New York State Integrated Pest Management Program | Cornell Cooperative Extension

Citronella & Citronella Oil Profile

Active Ingredient Eligible for Minimum Risk Pesticide Use

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Active Ingredient Name: Citronella and Citronella oil

Active Components: Citronellal, citronellol, geraniol, camphene, pinene, dipenthene, limonene, linalool and borneol

CAS Registry #: 8000-29-1

U.S. EPA PC Code: 021901

CA DPR Chem Code: 143

Other Names: Oil of citronella

Other Codes: EINECS: 289-753-6 (Ceylon), 294-954-7 (Java), FEMA: 2308

Summary: Citronella oil is derived from two perennial grasses of the *Cymbopongon* species. As a pesticide, the essential oil is primarily used as a mosquito repellent, but also has other insecticidal, acaricidal and herbicidal activity. It is not considered harmful to humans and pets but may cause skin irritation. Citronella can be toxic to pollinators.

Pesticidal Uses: Repellent of mosquitoes and other biting insects; herbicide.

Formulations and Combinations: Citronella may be used with other essential oils and botanical insecticides. Those eligible for exemption include cinnamon oil, clove oil, eugenol, lemongrass oil, and cinnamon oil. Registered products may contain the botanical neem. Paraffin, beeswax and other waxes may be added when used in insect repellent candles. Citronella in incense sticks may be combined with various wood powders, binders and other incense base ingredients. Gel formulations are made with vegetable gums, such as guar, tragacanth and gum arabic. Wetting agents and surfactants—including sodium lauryl sulfate, glycerol and gelatin—may also be used as formulants in exempt products. Registered products may contain other inert ingredients not eligible for exemption.

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: American Candle, Bug Master, Candle Corp of America, Elons Essential Oil, Empire Manufacturing, Fiebing Chemical Co., Farnam, Flintlock Ltd, General Wax and Candle, HDDES Group, Lamplight, LR Wilson, Natural Research, PJ Maxwell, Perycut Chemie, Plantabs, Primavera, Quantum, SC Johnson & Sons, Spectrum, Tender.

Safety Overview: While some individuals suffer skin irritation, risks to human health and the environment are regarded as minimal by the EPA. When a registered pesticide containing citronella is used according to the label, no harm to humans, pets or the environment is expected (US EPA 1999). Citronella can post potential acute toxicity and sublethal effects to pollinators and other beneficial insects. (Xavier et al, 2010, 2015).

Background

Citronella refers to two species of essential-oil–bearing, perennial tropical grasses of the genus *Cymbopogon.* One is Ceylon (*C. nardus*) and the other is Java (*C. winterianus*). They are morphologically and biochemically distinct from one another (Wijesekera et al. 1973). Their main sources being Indonesia, Sri Lanka and China (Tiwari 2009). Citronella takes about 7-9 months from planting to first harvest. The main exporter, Indonesia, accounts for nearly 80% of the world's supply, and provides two-thirds of the US supply, citronella oil's largest importer. (ITC 2014). In 2013, the next three leading exporters of citronella oil to the US were China, France and Sri Lanka, accounting for most of the rest. Citronella is sometimes called 'lemongrass oil' (Isman and Machial 2006), but lemongrass oil is covered in a separate profile because its primary active ingredient is citral and it comes from the *Cymbopogon* species *C. flexuosus*, *C. citratus*, and *C. pendulus*. Oil from those species is also sometimes referred to as 'citronella oil' (Barber and Hall 1950).

The principle distinct active components of *C. winterianus* are the monoterpene aldehyde citronellal and its oxidation product, citronellol (Gildemeister and Hoffmann 1916; Khan and Abourashed 2010). Citronellal and geraniol are the active constituents in greatest abundance in *C. nardus* essential oil (Wijesekera 1973; Mahalwal and Ali 2003). Content of these substances can vary widely, with varietal differences thought to account for the greatest variation in the chemical composition (Wijesekera et al. 1973). Geranyl acetate is also listed as a biocidal component (Gwynn 2014). Other biologically active constituents of citronella include camphene, pinene, dipenthene, limonene, linalool, and borneol (Gildemeister and Hoffmann 1916; Khan and Abourashed 2010).

Citronella has been used since antiquity as a fragrance, aroma and flavor (Barber and Hall 1950). Its first uses as an insecticide were recorded around 1882, making it one of the first botanical insecticides (Gerberg and Novak 2007). Citronella was recommended as a mosquito repellent for camping, along with cedar oil and camphor spirits, early in the 20th century (Felt 1917). The insect repellent and insecticidal properties of citronella oil were the subject of much research prior to the advent of synthetic organochlorine insecticides. Citronella candles were introduced in the 1940s (Driscoll 1943). Prior to the invention of N,N diethyl 3-methylbenzamide (DEET) in 1946, citronella was the most widely used insect repellent (Katz et al. 2008). Later formulations used combustible materials, such as sawdust from cedar and other aromatic burning woods, soaked in citronella and made into incense or burnable coils. Citronella oil is also used as an herbicide for the control of ragwort (*Senecio jacobaea*) (Gwynn 2014).

In addition to biopesticidal uses, citronella oil is used as a flavoring agent in many food products including alcoholic and non-alcoholic beverages, candies, baked goods, gelatins, and puddings. It is also an ingredient in perfumery, soaps, candles and incenses, dietary supplements and traditional medicines, including as a natural intestinal parasite remedy, and aromatic teas (Khan and Abourashed 2010).

Chemical and Physical Properties

The physical and chemical properties of citronella oil appear in Table 1. Where values for citronella are missing, the values for citronellal are reported.

Table 1

Physical and Chemical Properties of Citronella and Citronella Oil

Property	Characteristic/Value	Source(s)
Molecular Formula:	N/A	
Molecular Weight:	N/A	
Percent Composition:	Ceylon: about 60% geraniol, about 15% citronellal, 10-15% camphene and dipentene, small quantities of linalool, borneol. Java: 25-50% citronellal, 25-45% geraniol.	(Merck 2015)
Physical state at 25°C/1 Atm.	Liquid	(Merck 2015)
Color	Colorless to pale yellow, gradually becoming reddish	(Merck 2015)
Odor	Sweet-floral, grassy, camphoraceous	(Andersen 1997)
Density/Specific Gravity	Ceylon: 0.897-0.912Java: 0.885-0.900	(Merck 2015)
Melting point	Not found	
Boiling point	170°C	(Andersen 1997)
Solubility	Slightly soluble in water; soluble in 10 vols 80% alcohol	(Merck 2015)
Vapor pressure (Major components)	Citronellal 0.23, Citronellol 0.015, Camphene 3.0, Limonene 1.4, Geraniol 0.02	(Andersen 1997)
pH	Not found	
Octonol/Water (K_{ow}) coefficient	Very large because of high solubility in octanol	(Andersen 1997)
Viscosity	Not found	
Miscibility	Immiscible	(TMK Packers 2010)
Flammability	Flash point: 170°C	(Andersen 1997)
Storage stability	Stable under normal conditions	(Andersen 1997)
Corrosion characteristics	Non-corrosive	(Andersen 1997)
Air half life (Citronellal)	0.492 hr	(EPI 2012)
Soil half life (Citronellal)	360 hrs (15 days)	(EPI 2012)
Water half life (Citronellal)	720 hrs (30 days)	(EPI 2012)
Persistence (Citronellal)	425 hrs	(EPI 2012)

Human Health Information

Oil of citronella has been used extensively since the 1940s without any adverse effects reports of concern (US EPA 1999; Katz et al. 2011). Nonetheless, the health and safety of citronella has been questioned (Cox 2005; Health Canada 2008; Maia and Moore 2011). There were 12 human health incidents involving citronella reported to the National Pesticide Information Center between April 1, 1996 and March 30, 2016 (NPIC 2016). Most reported incidents involved pesticide formulations with additional active ingredients. Where information was available, these incidents involved dermal or respiratory irritation, depending on whether the citronella was applied to skin or by burning candles.

Acute Toxicity

The acute toxicity of citronella oil appears in Table 2.

Table 2

Acute Toxicity of Citronella Oil

Study	Results	Source(s)
Acute oral toxicity	Rat. Java: >5,000 mg/kg Ceylon: 4,380 mg/kg	(Andersen 1997)
Acute dermal toxicity	Rabbit (both): >2,000 mg/kg	(Andersen 1997)
Acute inhalation	Rat. Ceylon: >5,000 mg/kgJava: 4 hr exposure LC_{50} > 3.1 mg/l	(Andersen 1997)
Acute eye irritation	Rabbit. Ceylon: Irritation cleared in 72 hrsJava: Irritation cleared in 7 days or less	(Andersen 1997)
Acute dermal irritation	Rabbit. Ceylon: Irritation present at 21 daysJava: All irritation resolved in 48 hrs	(Andersen 1997)
Skin sensitization	Guinea pig. Ceylon: SensitizerJava: Non-sensitizer	(Andersen 1997)

EPA concluded that citronella oil should be classified as Toxicity Category III, with a precautionary statement for "Skin Irritation" to be applied on registered pesticide labels for both Ceylon and Java types—even though the Ceylon-type is categorized as a dermal sensitizer, but the Java-type is not (Andersen 1997).

Sub-chronic Toxicity

The EPA waived all sub-chronic toxicity requirements for citronella and citronella oil (McDavit 2010). No other studies related to the sub-chronic toxicity of citronella or citronella oil were found. Health Canada's re-evaluation of citronella noted evidence of reproductive and developmental toxicities of concern (Health Canada 2008). Sub-chronic toxicity of the active substance citronellol is summarized in Table 3. Rats fed citronellol had depressed food intake and growth attributed to the substance's unpalatability. However, there were no observable adverse effects on the efficiency of food utilization or physiological criteria (Belsito et al. 2008). Urinalyses were normal and kidney and liver weights were not changed.

Table 3

Sub-chronic Toxicity of Citronellol

Study	Results	Source
Repeated Dose 28-day Oral Toxicity Study in Rodents	Not found	
90 day oral toxicity in rodents	Rats: NOAEL = 50 mg/kg/day	(Belsito et al. 2008)
90 day oral toxicity in non-rodents	Not found	
90 Day dermal toxicity	Not found	
90 Day inhalation toxicity	Rat maternal NOAEL= 0.3 mg/kg	(Belsito et al. 2008)
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	(FFHPVC 2004)
Reproduction and fertility effects	Not found	(FFHPVC 2004)

Citronella has been reported to cause skin dermatitis and eczema in certain sensitive individuals (Opdyke 1973). The sub-chronic health effects on rats exposed to cigarettes with citronella oil added at 12 ppm in a 90 day-inhalation study were indistinguishable from those rats exposed to the control cigarettes (Baker et al. 2004).

Chronic Toxicity

The chronic toxicity of citronella oil appears in Table 4.

Table 4

Chronic Toxicity of Citronella Oil

Study	Results	Source(s)
Chronic toxicity	Ames: Negative	(Andersen 1997)
Carcinogenicity	Not found	
Combined chronic toxicity & carcinogenicity	Chinese hamster: Negative	(Andersen 1997)

Citronella and citronella oil are not identified as carcinogens by the International Agency for Research on Cancer (IARC 2014); 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 2015). The active substance citronellal showed weak evidence of chromosome damage or clastogenicity in a non-standard assay for chromosomal aberrations, but assays for sister chromatid exchanges yielded negative results (JECFA 2004) .

Environmental Effects Information

Effects on Non-target Organisms

The effects of citronella and citronella oil are summarized in Table 5.

Table 5

Effects of Citronella and Citronella Oil on Non-target Organisms

Study	Results	Source(s)
Avian Oral, Tier I	Bobwhite quail (*Colinus virginianus):* LC_{50}: 2,250 mg/kg (practically non-toxic) NOEL: 1,350 mg/kg	(Andersen 1997)
Non-target plant studies	Not found	
Non-target insect studies	Not found	
Aquatic vertebrates	Rainbow trout (*Oncorhynchus mykiss*) LC_{50}: >17.3 mg/L	(Andersen 1997)
Aquatic invertebrates	*Daphnia magna* EC_{50}: >26.4 Mg/L	(Andersen 1997)

In their review of registered products having both low concentrations of active ingredient and low use volume, the EPA waived data for all non-target organisms because of the rapid degradation in the environment through biological, physical, and/or chemical processes (Matthews 2012). The EPA also concluded that citronella and other flower oils had "no effect" on threatened and endangered species. There were five animal incidents involving citronella reported to the National Pesticide Information Center between April 1, 1996 and March 30, 2016 (NPIC 2016).

Citronella can be toxic to beneficial insects—including pollinators—at higher application rates. For example, compared with six other botanical insecticides, including neem and rotenone, citronella had the highest acute toxicity to adult honey bees (*Apis mellifera*) at doses of 10 ml/L (Xavier et al. 2010). By contrast, the same study found that citronella was one of two botanicals not toxic to honey bee larvae. Another study found that citronella failed to repel Africanized honey bees (Abramson et al. 2006). Generally, citronella is not inhibitory of bacteria, microbial fungi and other microorganisms, but shows some specific activity (Pauli and Schilcher 2009).

Environmental Fate, Ecological Exposure, and Environmental Expression

Citronella oil is considered Readily Biodegradable (EPI 2012). Other environmental fate, ecological exposure and environmental expression studies were not required for citronella oil because no adverse effects were suggested by the literature (Andersen 1997). While the risks to the environment seem relatively low, the many data gaps about environmental fate and ecological exposure are a cause of concern to some (EFSA 2012). When exposed to elevated levels of ozone, which can commonly occur at night time in smoggy areas, citronella plumes will form higher levels of secondary organic aerosols (Bothe and Donahue 2010). These aerosols have not been characterized for their risk of human exposure or chronic toxicity. Between April 1, 1996 and March 30, 2016, there were 19 incidents involving citronella reported to the National Pesticide Information Center that were not specified as human health or animal related (NPIC 2016). One of these incidents was in New York.

Efficacy

Insecticidal Activity

The primary insecticidal use of citronella is as mosquito repellent. Efficacy claims for mosquitos and ticks can be made for 25(b) exempt citronella products as long as they do not mention that they prevent specific mosquito- or tick-borne diseases (US EPA 2016). The mode of action against insects is mostly non-toxic, although some studies show significant mortality to some species of insects at certain life stages (Wiltz et al. 2007; Phasomkusolsil and Soonwera 2011). One explanation is that terpenes in the oil block insects' neural pathways and disrupt their movements and metabolism (Ritter 2006). More specifically, citronellal was found to interfere with the cation channel in fruit fly (*Drosophila* spp.) olfactory receptors (Kwon et al. 2010).

A meta-analysis found that citronella oil consistently repelled *Aedes*, *Anopheles* and *Culex* mosquito adults in replicated studies (Kongkaew et al. 2011). Citronella in the formulated product Natrapel repelled *Aedes albopictus* for 1.3 hours (Xue et al. 2007). *Aedes albopictus, Culex nigripalpis* and *Ochlerotatus triseriatus* were repelled by citronella in laboratory studies, but not for as long as the synthetic repellent DEET (N,N-Diethyl-3-methylbenzamide) (Barnard and Xue 2004). This was consistent with a previous study that found all botanical repellents less persistent than DEET (Fradin and Day 2002). DEET products had complete protection times lasting over an hour, while citronella products had complete protection times ranging from less than a minute (in the case of a wristband) to an average of about twenty minutes: one DEET product lasted over five hours on average.

Various substances can be added to citronella to prolong its biological activity (Maia and Moore 2011). These include adding inert ingredients, like glycerol, gelatin or gum Arabic, permitted in minimum risk pesticide products. The addition of 5% vanillin to citronella oil doubled the length of protection provided by the latter against *Anopheles* mosquitoes (Tawatsin et al. 2001). Due to dermal sensitization and the fact that children may put hands treated with citronella in their eyes or mouths, the allowable amount in insect sprays is limited. The concentrations of citronella oil used in these studies ranged between 10-25%. which is much higher than the allowable amount for insect sprays for human skin in Washington and California (California Code of Regulations 2013; WSDA 2016).

In killing the *Aedes aegypti*, *Culex quinquefasciatus* and *Anopheles dirus* adults in Thailand, the insecticidal activities of the essential oils lemongrass and citronella oil are comparable and more potent than some other essential oils such as basil, cloves, and eucalyptus (Phasomkusolsil and Soonwera 2011). In a laboratory study, lemongrass essential oil at 10% concentration killed 100% of all three species of mosquitoes within 24 hours of exposure. The testing was conducted by the standard WHO protocol using diagnostic kits that exposed mosquitoes in tubes to paper impregnated with the essential oils. Additionally, citronella oil at 10% also killed 100% of *Culex quinquefasciatus* and *Anopheles dirus* and 97.6% of *Aedes aegypti* adults in 24 hours post exposure.

Topical application of citronella oil is more effective in repelling mosquitoes than when it is applied as a wrist band; in comparing personal diffusers with wristbands, diffusers are more effective (Revay et al. 2013). Similarly, microencapsulated citronella oil applied on fabrics provided longer protection from *Aedes aegypti* mosquitoes than when citronella oil mixed in alcohol was applied on the fabrics. The mosquitoes were repelled for almost 21 days from microencapsulated citronella oil-treated fabrics, compared to 5 days from the citronella oil in alcohol treatment (Specos et al. 2010). Decreasing droplet size can prolong the release and increase the efficacy (Sakulku et al. 2009).

By contrast, citronella was only marginally effective as a mosquito larvicide. *Aedes aegypti* had mortality rates of 6.67%, 43.3% and 60% respectively after 1, 12 and 24 hours of exposure (Amer and Mehlhorn 2006). The same study found 13 essential oils that were 100% effective after 24 hours. Another study looked at the excito-repellency and knockdown efficacy of various essential oils when used against *Ae. aegypti* in Thailand. The results found citronella oil to have the least effective knockdown effect, with an LC_{50} of 6.7% (Boonyuan et al. 2014). Citronella candles were deemed ineffective in reducing *Aedes* spp. mosquito bites in Canada (Lindsay et al. 1996). Use of citronella smoke by burning mosquito coils also produced relatively poor results compared to various synthetic pyrethroids; dimefluthrin, meperfluthrin and transallethrin all resulted in greater mortality than citronella against *Anopheles albimanus, Aedes albopictus* and *Culex quinquefasciatus* (Xue et al. 2012). Citronella is less persistent than DEET, and needs to be reapplied more often to get comparable results (Katz et al. 2008).

Laboratory assays were conducted to evaluate the repellency and contact toxicity of citronella and five other essential oils to the Argentine ant (*Linepithema humile*), and the red imported fire ant (*Solenopus invicta*). Both species crossed barriers treated with multiple rates of citronella and other essential oils less frequently than paired control barriers (Wiltz et al. 2007). Citronella oil killed 50% of Argentine ants in 34.3 min and was the only treatment to cause 100% Argentine ant mortality after 24 h. Only citronella oil caused significant mortality of red imported fire ants, with 50.6% of the ants being dead after 24 h of continuous exposure.

Citronella oil repels both body (*Pediculus humanus* var. *humanus*) (Mumcuoglu et al. 1996) and head lice (*Pediculus humanus* var. *capitata*) (Mumcuoglu et al. 2004). In an Australian study, citronella combined with neem and coconut oil was as effective at preventing head lice transmission as DEET, but less effective than tea tree oil (Canyon and Speare 2007). Neem and coconut oil are not eligible to be included in minimum risk pesticide products.

Efficacy studies have also been performed with isolated citronellal. Topical application of citronellal on adult houseflies (*Musca domestica*) was relatively effective compared to several other monoterpenoid aldehydes, ketones and alcohols extracted from mints or cinnamon or citronella. The LC_{50} was 60 gram of citronellal per fly.

As a fumigant against adult houseflies and red flour beetles (*Tribolium castaneum*), citronellal is very potent to houseflies (LC_{50} = 2 µg/cm^3), but required higher concentration to kill beetles LC_{50} >840 µg/cm^3 (Rice and Coats 1994).

Citronella has acaricidal activity as well. Citronella oil at concentrations of 12.5% and higher are very effective in killing tropical horse tick larvae (*Anocentor nitens*) (Clemente et al. 2010). Also, a commercially formulated pesticide product (Bug Assassin)—with 0.006% citronella oil as one of the active ingredients, along with eugenol, peppermint oil, and sodium lauryl sulfate—provided about 90% control of two-spotted spider mites (*Tetranychus urticae*) up to 14 days after treatment and up to 80% by 21 days. This shows good residual activity (Cloyd et al. 2009).

Citronella failed to demonstrate efficacy against Homopteran pests. The product Bug Assassin applied at recommended doses failed to result in an LD_{50} of either aphids or whiteflies in greenhouses (Cloyd et al. 2009). Three species of kissing bugs (*Triatoma rubida, T. protracta* and *T. recurva*) were also not effectively repelled by citronella (Zamora et al. 2015).

Blocks of Douglas fir treated with citronellal and exposed to Formosan termites (*Coptotermes formosanus*) did not differ significantly from the no-treatment control in both termite mortality and as a repellent (Cornelius 1997). Compared with eugenol and geraniol, citronellal was also relatively ineffective in laboratory experiments and in the prevention of termite tunneling.

On the other hand, citronella can also be used as an insect attractant. For example, citronella oil was observed to be a strong attractant of the fruit fly *Dacus zonatus*, a pest of peaches and mangos in Asia (Howlett 1912).

Fungicidal Activity

A survey of the literature found citronella inhibitory but generally not toxic to a broad range of gram-negative and –positive bacteria, fungi and yeasts (Pauli and Schilcher 2009). Oils from *C. nardus* and its active constituents were screened for anti-fungal properties against nine fungal strains: *Aspergillus candidus, A. flavus, A. versicolor, Eurotium amstelodami*, *E. chevalieri*, *Penicillium adametzii*, *P. citrinum*, *P. griseofulvum*, and *P. islandicum.* Citronellal and linalool extracted from *C. nardus* oil were both highly effective against all species (Nakahara et al. 2013).

Herbicidal Activity

Citronella and its active constituent citronellal can be phytotoxic and inhibit the growth of weeds. The mode of action is the creation of necrosis and subsequent death in plant tissue (Gwynn 2014). Citronella is used to spot treat *Senecio jacobaea* (Ragwort) in grasslands, green cover, and land temporarily removed from production (EFSA 2012).

A laboratory bioassay in sand culture looked at citronella's effects on seed germination of six weed species: billy goat weed (*Ageratum conyzoides*), common lambsquarters (*Chenopodium album*), parthenium ragweed (*Parthenium hysterophorus*), prickly malvastrum (*Malvastrum coromandelianum*), coffee weed (*Cassia occidentalis*) and littleseed canarygrass (*Phalaris minor*). A 94% solution of citronellal was applied to seeds at concentrations of 5, 10, 25, 50 and 100 µg citronellal/g of sand, in which they were planted. At the 100 µg/g dose, none of the seeds of any weed species emerged. *A. conyzoides* and *P. hysterophorus* were the most susceptible weed species tested and did not emerge at 50 µg/g sand treatment (Singh et al. 2006).

Citronellal is thought to impair photosynthetic and respiratory metabolism, disrupt cuticular wax, clog stomata, shrink epidermal cells and cause rapid electrolyte leakage. Post-emergence application of citronella has been equally effective in causing chlorosis, necrosis, wilting and finally death of weeds (Ganjewala 2009).

Vertebrate Animal Activity

Dogs wearing citronella oil-infused collars exhibited less 'nuisance barking' (Segelken 1996).

Standards and Regulations

EPA Requirements

Citronella and citronella oil are not exempt from the requirement of a tolerance [40 CFR 180]. EPA

requires all registered citronella oil products with label claims for repelling mosquitoes, fleas and ticks to have specific instructions pertaining to effective repellent activity (i.e., protection time). Because the minimum acceptable protection time is one hour, the following statement pertaining to maintenance of repellent activity must appear in the direction for use: "For maximum repellent effectiveness of this product, repeat applications at 1 hour intervals." (Andersen 1997).

FDA Requirements

Citronella and Citronella oil are Generally Recognized As Safe (GRAS) when used as food ingredients [21 CFR 182.20].

Other Regulatory Requirements

Citronella may be used to denature alcohol used in various personal care products, pharmaceuticals, antiseptic and sterilizing solutions, disinfectants, insecticides, fungicides, and other biocides [27 CFR 21.105].

Citronella and citronella oil from natural sources are allowed by the USDA's National Organic Program (NOP) [7 CFR 205].

Washington State Department of Agriculture requires products with citronella to carry the following warning: "CAUTION, a dermal sensitization precautionary statement, a prohibition against application to the hands of children, and use directions requiring adult supervision during application to children." Formulations greater than 1% and intended for contact with human skin must be submitted for review (WSDA 2016).

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