New York State Integrated Pest Management Program | Cornell Cooperative Extension

Cottonseed Oil Profile

Active Ingredient Eligible for Minimum Risk Pesticide Use

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Label Display Name: Cottonseed oil

Active Components: Cottonseed oil composed of various fatty acids, including gossypol

CAS Registry #: 8001-29-4

U.S. EPA PC Code: 031602

CA DPR Chem Code: 1015

Other Names: Cotton oil, cottonseed acidulated soapstock, Deodorized cottonseed oil, Gossypium oil, Oleum gossypii, Aceite de algodon (Spanish), cottonseed oil

Other Codes: CHEMBL2108929; EINECS 232-280-7

Summary: Cottonseed oil is an edible oil that is commonly used in a wide range of foods. Some people are allergic. Carcinogenicity studies are equivocal; cottonseed oil may be a co-carcinogen. As a pesticide, it is mainly used as an adjuvant or carrier with insecticides. The mode of action for cottonseed oil is considered non-toxic to insects and mites, acting mainly through suffocation.

Pesticidal Uses: Primarily used as a carrier or solvent. Other uses include as a pediculicide (lice control); acaricide, insecticide, a postharvest protective coating for fruit and grains, and a preservative fungicide for fruit. Also used as an antimicrobial, fungicide, or herbicide.

Formulations and Combinations: Various anti-oxidants such as BHA, BHT, tocopherols, or olibanum (*Boswellia carterii*) oil.

Basic Manufacturers: Abitec, Amber, Arista, British Arkady, Cargill, Columbus, Goodfood, JG Boswell; National Cottonseed; Penta; Ruger; Sigma-Aldrich; Spectrum; Tri-K.

Safety Overview: A small percentage of the population has allergic reaction to cottonseed and its constituent, gossypol. Cottonseed oil is considered an 'equivocal carcinogen' by the Registry of the Toxic Effects of Chemical Substances (RTECS) criteria and may be a co-carcinogen.

Background

Cottonseed oil is extracted from the seeds of cotton plants (*Gossypium herbaceum, G. barbadense* and *G. hirsutum*) and other related species of *Gossypium*. Current production technology for the extraction of cottonseed oil generally relies on crushing with solvent extraction.

Cottonseed oil contains gossypol, a polyphenolic compound that is toxic to livestock (Schneider 2012). Gossypol has known human health effects as well. No currently EPA-registered cottonseed oil products were found in the EPA Pesticide Product Labeling System database.

Chemical and Physical Properties

The physical and chemical properties of Cottonseed oil appear in Table 1.

Table 1

Physical and Chemical Properties of Cottonseed Oil

Property	Characteristic/Value	Source
Molecular Formula:	N/A	
Molecular Weight:	N/A	
Percent Composition:	Fatty acids: Linoleic (46.7-58.2%) Palmitic (21.4-26.4%), Oleic (14.7-21.7), Stearic (2.1-3.3%), Myristic (0.6-1.0%), Palmitoleic (0.0-1.2%), other fatty acids; unsaponifiable tocopherol <1%.	(O'Brien et al. 2005)
Physical state at 25°C/1 Atm.	Liquid	(Merck 2015)
Color	Pale yellow	(Merck 2015)
Odor	Practically odorless	(Merck 2015)
Density/Specific Gravity	0.915-0.921 at 25°C	(Merck 2015)
Melting point	0° to –5° C	(Merck 2015)
Boiling (smoke) point	232°C (450°F)	(O'Brien et al. 2005)
Solubility	Slightly soluble in alcohol	(Merck 2015)
Vapor pressure	Not found	
pH	N/A	
Octonol/Water (K_{ow}) coefficient	3.08	(EPI 2012)
Viscosity	η = 80 mPa□s at 20°C	(Thomas 2000)
Miscibility	Miscible in chloroform, ether, solvent hexane, carbon disulfide, petroleum ether	(Merck 2015)
Flammability	Combustible: Flash point 113°C (closed cup)	(Sigma-Aldrich 2015)
Storage stability	Stable under recommended conditions	(Sigma-Aldrich 2015)
Corrosion characteristics	Not found	
Air half life	2.21 hrs	(EPI 2012)
Soil half life	1,440 hrs	(EPI 2012)
Water half life	2,880 hrs	(EPI 2012)
Persistence	1,210 hrs	(EPI 2012)

Human Health Assessment

Acute Toxicity

The acute toxicity of cottonseed oil appears in Table 2. The results for acute dermal irritation and eye irritation are from tests using hydrogenated cottonseed oil (Madhaven 2001).

Table 2

Acute Toxicity of Cottonseed Oil

Study	Results	Source(s)
Acute oral toxicity	Rat: 275 ml/kg >82,620 mg/kg	(Boyd and Boulanger 1969; Sigma-Aldrich 2015)
Acute dermal toxicity	Not found	
Acute inhalation	Not found	
Acute eye irritation	Rabbit: Mildly irritating (Hydrogenated)	(Madhaven 2001)
Acute dermal irritation	Rabbit: Irritation scores of <1 on a scale of 0-8. (Hydrogenated)	(Madhaven 2001)
Skin sensitization	Not found	

Cottonseed oil, like other edible oils, can be toxic when consumed at a rate greater than what can be metabolized or excreted (Boyd and Boulanger 1969). Rats fed a protein deficient diet had lower acute oral toxicity levels, meaning that the toxic effect of the cottonseed oil was greater (Madhaven 2001).

Sub-chronic Toxicity

The sub-chronic toxicity of cottonseed oil appears in Table 3. In rats, hydrogenated cottonseed oil significantly changed sexual maturity and the length of the estrus cycle, but did not result in changes in the reproductive cycle (Madhaven 2001).

Table 3

Sub-chronic Toxicity of Cottonseed 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	Rabbits: Reduced blood glucose, inorganic phosphorous and cholesterol. (Hydrogenated)	(Madhaven 2001)
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	Rat: No effect on the F_0 generation; significant changes in sexual maturity and length of estrus in the F_1 generation. (Hydrogenated)	(Madhaven 2001
Prenatal developmental toxicity study	Not found	
Reproduction and fertility effects	Not found	

Chronic Toxicity

The chronic toxicity of cottonseed oil appears in Table 4.

Table 4

Chronic Toxicity of Cottonseed Oil

Study	Results	Source(s)
Chronic toxicity	*Drosophila*: Some point mutations	(HSDB 2015)
Carcinogenicity	Mice: Equivocal tumorigenic agent.	(Tinsley et al. 1982; Sigma-Aldrich 2015)
Combined chronic toxicity & carcinogenicity	Not found	

Cottonseed oil is not identified as a carcinogen by the International Agency for Research on Cancer (International Agency for Research on Cancer, World Health Organization 2014); is not on the California Proposition 65 list of known carcinogens (Cal-EPA 1997); and does not appear on the Toxics Release Inventory (TRI) Basis of OSHA Carcinogens (US EPA Toxics Release Inventory Program 2015).

On the other hand, cottonseed oil is considered an equivocal tumorigenic agent by RTECS criteria (Sigma-Aldrich 2015). A review of the epidemiological literature noted that there is a correlation between fat consumption and breast cancer (Welsch 1995). This does not necessarily mean that cottonseed oils or other fats are carcinogenic. Positive results for cottonseed oil as a carcinogen may be related to using the hydrogenated form, which is higher in trans-fatty acids (Welsch 1995).

Mice fed cottonseed oil had a higher incidence of spontaneous mammary tumors compared to test populations of mice consuming other vegetables oils (Tinsley et al. 1982). Cottonseed oil is used on some occasions as an experimental carcinogen and teratogen (Milne 2004). Several studies suggest that cottonseed oil is a co-carcinogen (Madhaven 2001; HSDB 2015).

Human Health Incidents

There were four human health incidents reported to the National Pesticide Information Center between April 1, 1996 and March 30, 2016 (NPIC 2016). All reported incidents involved products with other active ingredients on the label in addition to cottonseed oil.

Environmental Effects Information

Effects on Non-target Organisms

Gossypol concentrated from cottonseed oil was observed to be toxic to chickens (*Gallus domesticus*) (Henry et al. 2001). Cottonseed oil injected into chicken eggs resulted in significantly lower hatch rates than corn oil, but even at a dose of 0.15 ml/egg, over 50% of the eggs hatched (Ameenuddin and Sunde 1984).

Light cottonseed oil from glandless varieties produces no gossypol, but has cyclopropenoid fatty acids (CPFA), which are synergists with aflatoxins and are considered primary liver carcinogens. Rainbow trout (*Salmo gairdnerii*) fed 9.95% light cottonseed oil extracted from glandless varieties had significant numbers of hepatocellular carcinomas (Hendricks et al. 1980).

There were three animal-related incidents reported to the National Pesticide Information Center between April 1, 1996 and March 30, 2016 (NPIC 2016). All reported incidents involved other active ingredients in addition to cottonseed oil.

Environmental Fate, Ecological Exposure, and Environmental Expression

No leaching, photodegradation, or biodegradability data for cottonseed oil were found.

Environmental Incidents

There were five incidents reported to the National Pesticide Information Center between April 1, 1996 and March 30, 2016 that were not specified as human health or animal exposures (NPIC 2016). These included phytotoxicity on plants treated for mites or insects and accidental spills.

Efficacy

Insecticidal Activity

Plant and mineral oils have a long history in pest management, both as an active ingredient and as a spray adjuvant. The effects are mostly physical, with oils adhering to the surface of insects interfering with respiration, effectively suffocating them (Hesler and Plapp 1986). More specifically, when applied to adult target pests, vegetable oils block the insects' spiracles. When applied to eggs, vegetable oils prevent gas exchange with the egg membrane (Weinzierl 2000).

One study showed that 1 ml/kg of raw cottonseed oil applied to Mexican bean weevil (*Zabrotes subfasciatus*) resulted in 1% survival of adults and 5% emergence from eggs (Hill and Schoonhoven 1981). The same study showed that oleic acid—a constituent of cottonseed oil—applied at a rate of 1 g/kg on bean seeds had a toxic effect on the Mexican bean weevil comparable to that of cottonseed oil. Oleic was by far the most toxic of the fatty acids isolated from cottonseed oil. The authors suggested that oleic acid may have a more toxic mode of action by itself than the other constituents of cottonseed oil. An extension fact sheet reports that cottonseed oil is generally considered the most insecticidal of the vegetable oils, but did not provide any additional data (Cranshaw and Baxendale 2013). When compared with castor, linseed, rosin, and petroleum spray oils for control of various citrus pests, particularly red scale (*Chrysomphalus aurantii*), cottonseed oil was the most effective, with a time of lethal immersion ranging between 14 and 1,400 minutes (DeOng et al. 1927). However, cottonseed and the other vegetable oils were also more phytotoxic, resulting in defoliation of the citrus trees.

Cottonseed oil was almost as effective as peanut oil in the control of the sweet potato whitefly (*Bemisia tabaci*) adults, with 78% mortality after 24 hours of exposure to a 3% solution in ethanol (Fenigstein et al. 2001). However, the same study showed that castor oil was the most effective against B. tabaci eggs. The authors concluded that the mode of action was non-toxic, with suffocation and starvation from its efficacy as an antifeedant as the cause of mortality. Another study comparing cottonseed oil and castor oil in controlling B. tabaci reached the same conclusion, with both oils effective at reducing populations, but neither treatment was significantly better than the other (Butler et al. 1991). The latter study stated that cottonseed oil noticeably reduced populations of cotton aphids (*Aphis gossypii*), but did not report the data. In another study, crude cottonseed oil applied at a 10% solution caused 93% mortality of cotton aphids two days after treatment, compared with 40% mortality for a water control (Butler et al. 1988).

Cottonseed oil alone was slightly more effective at reducing B. tabaci in lettuce than insecticidal soap alone, with an average of 378 adults per plant for the cottonseed oil treated lettuce and 403 adults per plant on the soap treated lettuce after six days. However, cottonseed oil combined with insecticidal soap was more effective than cottonseed oil alone, with a mean count of 280 adults per lettuce plant (Butler and Henneberry 1989).

A commercial blend of 1.5% cottonseed oil, 0.10% cinnamon oil and 0.10% rosemary oil (Pharm Solutions Flower Pharm) achieved over 90% mortality of citrus mealybug (*Planococcus citri*) at the ready-to-use label rate (Cloyd et al. 2009). The product is 25(b) exempt.

Fungicidal Activity

Tests against hop mildew (*Sphaerotheca humuli*) growing on young hops (*Humulus lupulus*) plants in a greenhouse showed that cottonseed oil combined with soft soap (potassium salts of fatty acids) was effective at a rate of 0.25-0.50% solution, and when combined with an emulsifier was effective at a 0.25% solution (Martin and Salmon 1931). Such a formulation would not be eligible for 25(b) exemption. Cottonseed oil is used to coat citrus, as well as other fruit and fruit vegetables, in combination with various waxes to form a protective barrier that prevents mold and other spoilage organisms from being established (Trowbridge 1934). Cottonseed oil combined with beeswax, carnauba wax, and paraffin wax as inert ingredients would be eligible for exemption under 25(b).

Herbicidal Activity

While cottonseed oil is commonly included in herbicide formulations as a carrier and dispersant for fat-soluble herbicides, and marketed as an adjuvant with herbicides, no studies were found showing it had any direct herbicidal effects. Cottonseed oil was compared with various other vegetable and essential oils for its efficacy in injuring and killing various weed species, and did not injure dandelion *(Taraxacum officianale)* (Tworkoski 2002). Because it did not injure dandelion leaves, cottonseed oils was not tested on the other species in the study.

Standards and Regulations

EPA Requirements

EPA recognizes cottonseed oil as a commonly consumed food and approved for use on food and food crops (40 CFR 180.950).

FDA Requirements

Cottonseed oil is recognized as a food ingredient by FDA.

Other Regulatory Requirements

The National Institute of Occupational Safety and Health (NIOSH) recommends a maximum exposure limit of 10 mg/m3 (Sigma-Aldrich 2015).

Cottonseed oil is allowed by the USDA's National Organic Program (NOP) [7 CFR 205].

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