New York State Integrated Pest Management Program | Cornell Cooperative Extension

Castor Oil Profile

Active Ingredient Eligible for Minimum Risk Pesticide Use

Brian P. Baker and Jennifer A. Grant
New York State Integrated Pest Management, Cornell University, Geneva NY

Label Display Name: Castor oil

Active Components: Castor oil; Ricinoleic acid

CAS Registry #: 8001-79-4

U.S. EPA PC Code: 031608

CA DPR Chem Code: 1013

Other Names: Palma Christi oil; Ricinus oil; Ricinoleum; Tangantangan oil; Triglyceride of ricinus acids; Turkey Red oil (sulfated form); Blown oil (oxidated form); Phorbyol; Venelex; Xeandam; Optase; Trypsin complex

Other Codes: EINECS 232-293-8; FEMA 2263; RTECS: FI4100000

Summary: Castor oil is derived from the castor bean and is used for a variety of industrial and health-related applications. Its primary pesticidal use is as an insecticide, but it is also used as a repellent for moles, gophers, armadillos, and other burrowing vertebrate pests. While it is considered inedible, castor oil has some food processing applications and is also used in various pharmaceuticals and cosmetics.

Pesticidal Uses: Antimicrobial, insecticide, rodenticide, deer repellent, inert ingredient.

Formulations and Combinations: Fly paper, glue, pine tar, ethanol, eucalyptus oil; capsaicin; sodium lauryl sulfate; cinnamon oil; garlic oil; white pepper.

Basic Manufacturers: HJ Baker & Co.; Spectrum.

Safety Overview: Castor oil has a long history of safe use in pesticides and other applications, but the bean itself has toxic constituents. The laxative properties of castor oil can cause adverse health effects, such as dehydration and nutrient loss, when consumed. Castor oil may also cause dermal irritation.

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.

Background

Castor oil is derived from the cold-pressing of the seeds of the castor bean (*Ricinus communis*). While the traditional process involved cold-pressing unheated castor beans, most modern industrial sources pre-heat the beans. The oil may be solvent extracted using heptane or hexane, for a 10-20% yield from the beans (Naughton 2011). The oil may also be mechanically extracted using a hydraulic or screwpress. The oil is then usually fractionated to achieve a higher grade. Treatments include degumming by centrifugal force, alkali treatment to remove excess free fatty acids, deodorization by steam stripping, and decolorization using various ion exchange media, such as clays.

Unusual in that its main constituent is ricinoleic acid, castor oil has many properties that make it different from other vegetable oils (Hasenhuettl 2000). Castor oil may be dehydrated, ethoxylated, hydrogenated, oxidized, or sulfated. These forms, as well as boiled castor oil, have different physical and chemical properties from raw castor oil. For example, dehydrated castor oil is a drying oil, while unprocessed castor oil is not (Wicks 2000). It is not clear whether these treated forms of castor oil are allowed for use as a 25(b) active ingredient. All of these forms are found in pesticide products. Their mode of action is considered to be suffocation for most insect pests with some antifeedant properties, and asphyxiation for rodents. It is generally not considered to be an active biocide. The mode of action is further explained in the efficacy section. Oxidized castor oil is used as an adhesive in sticky fly paper (Merck 2015).

India is the largest producer, followed by China and Brazil (Naughton 2011). Castor oil has many industrial uses (Merck 2015). These include as a raw material for the preparation of chemical derivatives used in coatings, lubricants, surfactants and dispersants.

A number of commercially important polymers include castor oil as an ingredient. The main industrial use of castor oil is as a feedstock for the manufacture of nylon (Naughton 2011). It is the chief raw material for the production of sebacic acid, which is a basic ingredient in the production of synthetic resins and fibers. Plastics, oilcloths, and artificial leather are all manufactured from castor oil. Lubricant applications include use in machines, 2-cycle engine fuels, hydraulic fluids, molds, and metal drawing.

Sulfated castor oil, known as 'Turkey-red oil' is used for dyeing and finishing textiles. Dehydrated castor oil is used in a number of polymers and copolymers. The dehydrated form is considered a drying oil, and is used in varnishes, oil-based paints, enamels, caulks and putties. Oxidized castor oil (blown oil) is used to plasticize oilcloth, coat fabrics, and lacquers.

Foods, drugs and cosmetics all use castor oil as an ingredient, processing aid or intermediate. Food contact surfaces use castor oil as an agent to release foods from conveyor belts or other food contact surfaces. Highly viscous, it is used as an anti-sticking agent in hard candy manufacturing [21 CFR 172.876]. Traditionally used as a laxative, castor oil is known for its highly purgative effect (Merck 2015; Khan and Abourashed 2010).

Various soaps are made with castor oil as an ingredient, and cosmetics use castor oil as an emollient and lubricant. The highest concentrations in cosmetic products are found in lipsticks, which in some cases may be over 80% castor oil (Johnson 2007)

One of the most widespread pesticidal uses of castor oil is as an ingredient in fly strips. The oxidized form is mostly used for this purpose (Merck 2015). The preservative properties of castor oil allow it to be used in embalming fluids and as a treatment for rubber.

Castor oil was mentioned in the original scope document for 'fruit and vegetable oils' in the EPA's most recent flower and vegetable oils registration review (Moore 2010), and in the most recent work plan (McDavit 2010). Values reported are for raw, unprocessed, or untreated castor oil unless reported otherwise. When values for raw castor oil are not available, values for its main constituent, ricinoleic acid, are reported. In the absence of data for any of those forms, the value for the parameter is reported as "Not Found."

Chemical and Physical Properties

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

Table 1

Physical and Chemical Properties of Castor Oil

Property	Characteristic/Value	Source
Molecular Formula:	N/A	
Molecular Weight:	N/A	
Percent Composition:	Fatty Acids: ricinoleic 87%, oleic 7%, linoleic 3%, palmitic 2%, stearic 1; insoluble impurities <0.2%.	(Merck 2015)
Physical state at 25°C/1 Atm.	Liquid	(Merck 2015)
Color	Pale yellow	(Merck 2015)
Odor	Slight, characteristic oil	(Merck 2015)
Density/Specific Gravity	0.961-0.963 at 15°C	(Merck 2015)
Melting point	Solidifies at –10° – –18°C	(Merck 2015)
Boiling point	313°C	(Sigma-Aldrich 2015)
Solubility	Soluble in dimethyl sulfoxide, petroleum ether and alcohol	(Merck 2015; Johnson 2007)
Vapor pressure	0.00449	(EPI 2012)
Acid value	2.0	(Naughton 2011)
Octonol/Water (K_{ow}) coefficient	6.19	(EPI 2012)
Viscosity	η = 1,000 mPa·s at 20°C	(Thomas 2000)
Miscibility	Miscible in ethanol, methanol, ether, chloroform, glacial acetic acid.	(Merck 2015)
Flammability	Flash point:230°C	(Merck 2015)
Storage stability	Excellent keeping qualities, does not turn rancid unless exposed to excessive heat	(Merck 2015)
Corrosion characteristics	Non-corrosive to metals; corrosive to skin	(Naughton 2011; Sigma-Aldrich 2015)
Air half life	Ricinoleic acid: 1.25 hrs	(EPI 2012)
Soil half life	Ricinoleic acid: 416 hrs	(EPI 2012)
Water half life	Ricinoleic acid: 208 hrs	(EPI 2012)
Persistence	Ricinoleic acid: 739 hrs	(EPI 2012)

Castor oil does not dissolve in mineral oil or vegetable oils.

Human Health Information

Acute Toxicity

The acute toxicity of castor oil appears in Table 2.

Table 2

Acute Toxicity of Castor Oil

Study	Results	Source(s)
Acute oral toxicity	Rat: LD_{50} >10 g/kg Mice: LD_{50} >10 g/kg	(Irwin 1992)
Acute dermal toxicity	Not found	
Acute inhalation	Not found	
Acute eye irritation	Rabbit: Not irritating (Score 1/20)	(Johnson 2007)
Acute dermal irritation	Rat: Severely irritating (Score = 3/3).	(Johnson 2007)
Skin sensitization	Not found	

A cosmetic ingredient review was conducted on the toxicity of castor oil and various derivatives. While it did not cause mortalities at the highest doses administered to rats, the study found that the laxative properties of castor oil are known to cause acute diarrhea (Johnson 2007). The study also found that Ponies (*Equus ferus caballus*) administered 2.5 ml/kg bodyweight suffered severe diarrhea and acute colitis (Roberts et al. 1989). A subsequent study found that ponies treated with castor oil suffered intestinal damage 72 hours after being dosed (Johnson et al. 1993). Between one pint and one quart consumed by a 70kg (150 lb) person is believed to be the fatal toxic dose (Gosselin et al. 1976).

Castor beans contain ricin, often characterized as the most toxic plant derived compound, causing fatal poisonings in humans (Balint 1974; Olsnes 2004). Castor oil treated to remove proteins is believed not to contain any ricin and heat treatment breaks down any incidental amounts remaining (Audi et al. 2005).

Irritating and highly toxic gases may be generated by thermal decomposition or combustion of castor oil. Castor oil runoff can pollute surface water if it is diluted with water or is sprayed with water for fire control (Sigma-Aldrich 2015).

Sub-chronic Toxicity

The sub-chronic toxicity of castor oil appears in Table 3.

Table 3

Sub-chronic Toxicity of Castor Oil

Study	Results	Source
Repeated Dose 28-day Oral Toxicity Study in Rodents	No abnormalities	(Johnson 2007)
90 day oral toxicity in rodents	Rats: Increased liver weight in males Mice: Increased liver weight in both sexes	(Irwin 1992)
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	Rat: Significant increase in prostaglandin E2 in females	(Johnson 2007)
Combined repeated dose toxicity with reproduction/development toxicity screening test	Rats and Mice: No adverse effects.	(Irwin 1992)
Prenatal developmental toxicity study	Rats: Decrease in live fetuses in the test group.	(Johnson 2007)
Reproduction and fertility effects	Rats: Decreased number of live fetuses and increased post-implantation deaths.	(Johnson 2007)

Castor beans contain the powerful heat-stable allergen, ricinine (Khan and Abourashed 2010). However, it is believed to not be present in the oil, and cases of allergenicity from pharmaceutical use are rare (HSDB 2015).

Chronic Toxicity

The chronic toxicity of Castor oil appears in Table 4.

Table 4

Chronic Toxicity of Castor Oil

Study	Results	Source(s)
Chronic toxicity	Ames Test: Negative	(Irwin 1992)
Carcinogenicity	Negative	(Johnson 2007)
Combined chronic toxicity & carcinogenicity	Not found	

Castor oil is not identified as a carcinogen by the International Agency for Research on Cancer (IARC 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).

Human Health Incidents

The National Pesticide Information Center reported four human-health related incidents involving castor oil between April 1, 1996 and March 30, 2016 (NPIC 2016). All involved other active ingredients in addition to castor oil.

Environmental Effects Information

Effects on Non-target Organisms

The National Pesticide Information Center reported four animal related incidents involving castor oil between April 1, 1996 and March 30, 2016 (NPIC 2016). All involved other active ingredients in addition to castor oil.

Environmental Fate, Ecological Exposure, and Environmental Expression

No studies were found on the leaching, photodegradation, and biodegradability of castor oil.

Environmental Incidents

The National Pesticide Information Center reported nine incidents that were not human health or animal related that involved castor oil between April 1, 1996 and March 30, 2016 (NPIC 2016). Narrative data was not available for all of these incidents.

Efficacy

Insecticidal and Acaricidal Activity

A USDA entomologist reviewed 52 different papers and summarized the effectiveness of the castor bean and its constituents as insecticides (McIndoo 1945). The project sought uses for by-products of castor oil extraction—particularly the known toxic constituents ricin or ricinine (Haller and McIndoo 1943). The review is mostly of anecdotal evidence and bulletins that were not peer reviewed, with several observations that castor oil is effective as an insecticide.

Castor oil was compared with cottonseed, linseed, rosin, and petroleum spray oils for control of various citrus pests, particularly red scale (*Chrysomphalus aurantii*) with a lethal immersion time of 1,400 minutes. All the vegetable oils controlled the scale better than the light petroleum distillate, with cottonseed oil performing the best. However, the vegetable oils were also more phytotoxic (DeOng et al. 1927).

Castor oil was more effective than cottonseed, peanut, soybean, and sunflower oils in inhibiting the hatching of sweet potato whitefly (*Bemisia tabaci*) eggs, with 19% of the eggs being viable (Fenigstein et al. 2001). The result was significantly better than cottonseed, soybean, and sunflower oils, and comparable to peanut oil. The same study showed that a 3% solution of castor oil was effective at reducing the survival rates of larvae, with 7.9% survival for the first instar, 4.1% for the second instar, 14.0% for the third instar, and 19.0% for the fourth instar. However, 3% castor oil was only marginally effective against adults, with a 3% mortality after 2 hours, but a 75% mortality after 24 hours. Another study found slightly higher surviving population levels of B. tabaci larvae treated with castor oil compared with cottonseed oil treated, but the two treatments were not significantly different (Butler et al. 1991).

A formulation composed of 51% dimethecone in castor oil, with the rest of the formulation comprised of isopropanol was tested on Sri Lankan children infested with head lice (*Pediculus humanis*). The application killed all head lice in 92% of the 108 test subjects within the first hour (Izri et al. 2010).

Castor oil is used post harvest to coat stored food products. The pulse beetle (*Callosobrucus chinensis*) was inhibited by a 0.3% coating on the green gram or mung bean (*Phaseolus aureus*) (Mumigatti and Raguna-than 1977). Subsequent comparisons with other vegetable oils showed 1% castor oil effective at preventing emergence of pulse beetle on the red gram or pigeonpeas (*Cajanus cajan*) for 33 days, and highly effective after 66 days, but not as persistent as neem (*Azadirachta indica*) or karanj (*Pongamia glabra*) oils (Khaire et al. 1992). Chickpeas (*Cicer arietinum*) treated with 10 ml of castor oil applied post harvest were protect-ed from bruchid pests *Callosobruchus maculatus* for 150 days and Callosobruchus phaseoli for 90 days (Pacheco et al. 1995). Cowpeas (*Vigna unguiculata*) treated with castor oil were protected from *C. maculata*, a primary pest of cowpeas and other legumes. The LC_{95} for C. maculatus treated with castor oil was 10.94 mg/L, which made it more effective than hazelnut oil, which was also screened (Haghtalab et al. 2009).

Wooden stakes made from the *Acacia nilotica* tree were treated with castor oil by vacuum pressure, sur-face application, and dipping at concentrations of 10%, 15%, and 20% by all three methods, then dried by oven and in the sun, and buried in a pit with *Odontotermes obesus* termites. For all three types of applica-tions, at all rates and for both types of drying methods, the castor oil significantly reduced wood loss from termite damage compared with the untreated control (Ahmed et al. 2014). The 20% rate provided slightly but significantly higher control than the lower rates. The 20% concentration by the dipping process result-ed in the minimum percent loss, with 8.91% loss in sap wood and 7.62% loss in heart wood. Losses in the control were over 40% for heart wood and over 50% for sap wood.

The fall armyworm (*Spodoptera frugiperda*) was susceptible to castor oil at the larval and pupal stage. The experiment compared castor oil that was extracted with hexane, methanol, and ethyl acetate as the solvents. The methanol extracted castor oil was significantly more effective than the other two, with insectistatic activity evident at 160 ppm (Ramos-López et al. 2010). Doses of 9,600 and 16,000 ppm (0.96-1.6%) resulted in 0% larval viability. Further investigation found that the ricinine content in the methanol extracted oil was significantly greater because ricinine is soluble in methanol, and insoluble in hexane and ethyl acetate. The results were confirmed by the greater efficacy of isolated ricinine than castor oil at both stages of fall armyworm development (Ramos-López et al. 2010).

Rodenticidal Activity

Castor oil combined with other dehydrating agents can be used to exterminate rats and other non-emetic animals by plugging their pharynx, larynx, and esophagus—thereby choking them to death (Perry 2013). The castor oil is put in a matrix that includes starches. Possible dehydrants can be corn gluten meal, soybean oil, linseed oil, sodium chloride (salt), or cottonseed oil—all of which are eligible as 25(b) active ingredients.

Standards and Regulations

EPA Requirements

Castor oil is exempt from the requirement of a tolerance [40 CFR 180.950] and is thus permitted for use on food crops. It is also partially exempt from reporting under the Toxic Substances Control Act (TSCA) [40 CFR 711.6(a)(iv)]. The EPA specifies that to be eligible as an active ingredient exemption from registration, castor oil must be United States Pharmacopeia (U.S.P.) or equivalent grade [40 CFR 152.25(f) Table 1].

FDA Requirements

The FDA approves specific uses of castor oil in foods and pharmaceutical products. Castor oil is not explicitly Generally Recognized As Safe (GRAS) as a food additive [21 CFR 184]. However, the FDA has recognized that castor oil is Generally Recognized As Safe and Effective (GRASE) for over the counter (OTC) use as a laxative (Johnson Jr 2007; US FDA 2010). As a food additive, it may be used as a releasing agent in hard candy production at levels not to exceed 500 ppm in the hard candy, and may be used as a protective component of vitamin and mineral tablets [21 CFR 172.876]. As a prior-sanctioned food ingredient, dehydrated castor oil may be used as a drying oil for resins used in food packaging [21 CFR 181.26]. Castor oil is also approved as a diluent for the color additive guaiazulene [21 CFR 73.2180], lubricant for incidental contact with food [21 CFR 178.3570], coating for cellophane [21 CFR 177.1200], and defoaming agent used in coatings [21 CFR 176.200]. For veterinary use, castor oil is approved as a topical treatment for wounds [21 CFR 524.2620].

Other Regulatory Requirements

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

Literature Cited

Ahmed, S, R Fatima, MS Nisar, and B Hassan. 2014. "Evaluation of Castor Bean Oil on *Acacia nilotica* as Wood Preservative against *Odontotermes obesus* (Ramb.)(Termitidae: Isoptera)." *International Wood Products Journal* 5 (1): 5–10.

Audi, Jennifer, Martin Belson, Manish Patel, Joshua Schier, and John Osterloh. 2005. "Ricin Poisoning: A Comprehensive Review." *Journal of the American Medical Association* 294 (18): 2342–2351.

Balint, GA. 1974. "Ricin: The Toxic Protein of Castor Oil Seeds." *Toxicology* 2 (1): 77–102.

Butler, GD, SN Puri, and TJ Henneberry. 1991. "Plant-Derived Oil and Detergent Solutions as Control Agents for *Bemisia tabaci* and *Aphis gossypii* on Cotton." *Southwestern Entomologist* 16 (4): 331–37.

Cal-EPA. 1997. "Prioritized Candidate Chemicals under Consideration for Carcinogenicity Evaluation." Sacramento, CA: California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/prop65/pdf/batch1.pdf.

DeOng, ER, H Knight, and JC Chamberlin. 1927. "A Preliminary Study of Petroleum Oil as an Insecticide for Citrus Trees." *Hilgardia* 2 (9): 351–384. doi:DOI:10.3733/hilg.v02n09p351.

EPI. 2012. "Estimation Programs Interface (EPI) Suite (V4.11)." Washington, DC: US EPA Office of Pesticides and Toxic Substances.

Fenigstein, Annie, Miriam Eliyahu, S. Gan-Mor, and D. Veierov. 2001. "Effects of Five Vegetable Oils on the Sweetpotato Whitefly *Bemisia tabaci*." *Phytoparasitica* 29 (Copyright (C) 2015 American Chemical Society (ACS). All Rights Reserved.): 197–206. doi:10.1007/BF02983451.

Gosselin, RE, HC Hodge, RP Smith, and MN Gleason. 1976. *Clinical Toxicology of Commercial Products: Acute Poisoning*. Baltimore, MD: Williams & Wilkins.

Haghtalab, N, N Shayesteh, and S Aramideh. 2009. "Insecticidal Efficacy of Castor and Hazelnut Oils in Stored Cowpea against *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae)." *Journal of Biological Sciences* 9 (2): 175–179.

Haller, HL, and NE McIndoo. 1943. "The Castor-Bean Plant as a Source of Insecticides." *Journal of Economic Entomology* 36 (4): 638–638.

Hasenhuettl, G. L. 2000. "Fats and Fatty Oils." In *Kirk-Othmer Encyclopedia of Chemical Technology*. John Wiley & Sons, Inc. http://dx.doi.org/10.1002/0471238961.0601201908011905.a01.pub2.

HSDB. 2015. "National Library of Medicine Hazardous Substances Data Bank (HSDB)." http://toxnet.nlm.nih.gov/newtoxnet/hsdb.htm.

IARC. 2014. "Agents Classified by the IARC Monographs." http://monographs.iarc.fr/ENG/Classification/.

Irwin, R. 1992. "NTP Technical Report on the Toxicity Studies of Castor Oil (CAS No. 8001-79-4) in F344/N Rats and B6C3F1 Mice (Dosed Feed Studies)." NTP Tox NIH 92-3131. Research Triangle, NC: National Toxicology Program. http://ntp.niehs.nih.gov/ntp/htdocs/st_rpts/tox012.pdf.

Izri, A., B. Uzzan, M. Maigret, M. S. Gordon, and C. Bouges-Michel. 2010. "Clinical Efficacy and Safety in Head Lice Infection by *Pediculus humanis capitis* De Geer (Anoplura: Pediculidae) of a Capillary Spray Containing a Silicon-Oil Complex." *Parasite (Paris, France)* 17: 329–35.

Johnson, CM, JM Cullen, and MC Roberts. 1993. "Morphologic Characterization of Castor Oil-Induced Colitis in Ponies." *Veterinary Pathology* 30 (3): 248–255.

Johnson Jr, Wilbur. 2007. "Final Report on the Safety Assessment of *Ricinus communis* (Castor) Seed Oil, Hydrogenated Castor Oil, Glyceryl Ricinoleate, Glyceryl Ricinoleate Se, Ricinoleic Acid, Potassium Ricinoleate, Sodium Ricinoleate, Zinc Ricinoleate, Cetyl Ricinoleate, Ethyl Ricinoleate, Glycol Ricinoleate, Isopropyl Ricinoleate, Methyl Ricinoleate, and Octyldodecyl Ricinoleate." *International Journal of Toxicology* 26: 31–77.

Khaire, V.M., B.V. Kachare, and U.N. Mote. 1992. "Efficacy of Different Vegetable Oils as Grain Protectants against Pulse Beetle, *Callosobruchus chinensis* L. in Increasing Storability of Pigeonpea." *Journal of Stored Products Research* 28 (3): 153–56. doi:10.1016/0022-474X(92)90034-N.

Khan, I. A., and Ehab A. Abourashed. 2010. *Leung's Encyclopedia of Common Natural Ingredients Used in Food, Drugs, and Cosmetics /*. 3rd ed. Hoboken, N.J. : John Wiley & Sons,.

McDavit, W. Michael. 2010. "Vegetable and Flower Oils Final Work Plan." Registration Review Case 8201. Washington, DC: US EPA Office of Pesticides and Toxic Substances. http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0904-0006.

McIndoo, N.E. 1945. "The Castor-Bean Plant as a Source of Insecticides: A Review of the Literature." E-666. Washington, DC: USDA. http://ufdc.ufl.edu/AA00026037/00001.

Merck. 2015. *The Merck Index Online*. Cambridge, UK : Royal Society of Chemistry,.

Moore, Jacob. 2010. "Product Chemistry Review for Vegetable and Flower Oils." Registration Review OPP-2011-0628-0003. Washington, DC: US EPA Office of Pesticides and Toxic Substances. http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0628-0003.

Mumigatti, SG, and AN Ragunathan. 1977. "Inhibition of the Multiplication of *Callosobruchus chinensis* by Vegetable Oils." *Journal of Food Science and Technology, India* 14 (4): 184–185.

Naughton, Frank C. 2011. "Castor Oil." *Kirk-Othmer Encyclopedia of Chemical Technology*. Wiley.

NPIC. 2016. "NPIC Special Report: 25(b) Incidents." Corvallis, OR: National Pesticide Informatiom Center.

Olsnes, Sjur. 2004. "The History of Ricin, Abrin and Related Toxins." *Toxicon* 44 (4): 361–370.

Pacheco, Ivânia A., M.Fernanda P.P.M. De Castro, Dalmo C. De Paula, AndréL. Lourenção, Scheilla Bolonhezi, and Margarida K. Barbieri. 1995. "Efficacy of Soybean and Castor Oils in the Control of *Callosobruchus maculatus* (F.) and *Callosobruchus phaseoli* (Gyllenhal) in Stored Chick-Peas (*Cicer arietinum* L.)." *Journal of Stored Products Research* 31 (3): 221–28. doi:10.1016/0022-474X(95)00010-5.

Perry, S.C. 2013. Rodenticide. US Patent Office 8,574,638, issued November 5, 2013. http://www.google.com/patents/US8574638.

Ramos-López, MA, S Pérez, GC Rodríguez-Hernández, P Guevara-Fefer, and Miguel A Zavala-Sanchez. 2010. "Activity of *Ricinus communis* (Euphorbiaceae) against Spodoptera Frugiperda (Lepidoptera: Noctuidae)." *African Journal of Biotechnology* 9 (9).

Roberts, MC, LL Clarke, and CM Johnson. 1989. "Castor-Oil Induced Diarrhoea in Ponies: A Model for Acute Colitis." *Equine Veterinary Journal* 21 (S7): 60–67.

Sigma-Aldrich. 2015. "Castor Oil Safety Data Sheet." MSDS 259853. St Louis, MO: Sigma-Aldrich, Inc. http://www.sigmaaldrich.com/MSDS/.

Thomas, Alfred. 2000. "Fats and Fatty Oils." *Ullmann's Encyclopedia of Industrial Chemistry*. Weinheim, Germany: Wiley-VCH Verlag GmbH & Co. KGaA.

US EPA Toxics Release Inventory Program. 2015. "Toxics Release Inventory (TRI) Basis of OSHA Carcinogens." Washington, DC: US EPA. http://www2.epa.gov/sites/production/files/2015-03/documents/osha_carcinogen_basis_march_2015_0.pdf.

US FDA. 2010. "OTC Active Ingredients." Washington, DC: US Food and Drug Administration. http://www.fda.gov/downloads/aboutfda/centersoffices/officeofmedicalproductsandtobacco/cder/ucm135688.pdf.

Wicks, Zeno W. 2000. "Drying Oils." In *Kirk-Othmer Encyclopedia of Chemical Technology*. John Wiley & Sons, Inc. http://dx.doi.org/10.1002/0471238961.0418250923090311.a01.pub2.