

# Lindane (Gamma-Hexachlorocyclohexane)

58-89-9

---

## Hazard Summary

Lindane is used as an insecticide on fruit and vegetable crops. Exposure to lindane may occur from eating contaminated food or by breathing air contaminated during formulation or use. Lindane is quite toxic to humans. The acute (short-term) effects of lindane through inhalation exposure in humans consist of irritation of the nose and throat and effects on the blood. Chronic (long-term) exposure to lindane by inhalation in humans has been associated with effects on the liver, blood, and nervous, cardiovascular, and immune systems. Animal studies indicate that lindane causes reproductive effects, while developmental effects have not been noted. Oral animal studies have shown lindane to be a liver carcinogen. EPA has classified lindane as a Group B2/C, possible human carcinogen.

---

Please Note: The main source of information for this fact sheet is the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Alpha-, Beta-, Gamma-, and Delta-Hexachlorocyclohexane (1) and EPA's Integrated Risk Information System (IRIS) (5), which contains information on oral chronic toxicity and the RfD.

## Uses

- Lindane is used as an insecticide on fruit and vegetable crops, for seed treatment, in forestry, and for livestock and pet treatment. (1,7)
- Lindane is no longer produced in the United States (however, it is still formulated in this country), and aerial application of the chemical is prohibited. (1)
- Lindane is also used topically for the treatment of head and body lice and scabies; it is available in 1 percent preparations as a lotion, cream, or shampoo. (1)

## Sources and Potential Exposure

- The most probable route of lindane exposure in humans is oral ingestion of food containing the insecticide. (1,7)
- Lindane may be released to the air during its formulation or use as an insecticide, from wind erosion of contaminated soil, or from release from hazardous waste sites. (1)
- Lindane has been detected in groundwater and surface water samples collected near hazardous waste sites; however, the chemical has only very rarely been detected in drinking water supplies. (1)
- Lindane has been listed as a pollutant of concern to EPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment. (2)

## Assessing Personal Exposure

- Lindane can be measured in the blood, urine, and semen of exposed individuals by gas chromatography.(1)

## Health Hazard Information

Acute Effects:

- Acute inhalation exposure to lindane in humans has resulted in irritation of the nose and throat, effects on the blood (anemia), and skin effects (elevated itchy patches of skin). (1,3)
- The major effects noted from oral exposure to lindane in humans are effects on the nervous system, such as seizures and convulsions. Vomiting and nausea and effects on the cardiovascular and musculoskeletal systems have also been reported. (1,3)
- Oral studies in animals have reported effects on the liver, kidney, immune, and nervous systems from acute lindane exposure. (1,3)
- Acute animal tests in mice and rats have shown lindane to have **high** acute toxicity from oral exposure. (4)

#### Chronic Effects (Noncancer):

- Chronic exposure to lindane by inhalation in humans has been associated with effects on the liver, blood, and nervous, cardiovascular, and immune systems. (1,3)
- Effects noted in animal studies from chronic oral exposure to lindane include effects on the blood (decrease in numbers of red and white blood cells), immune, and nervous systems, and the liver and kidney. (1,5)
- Reference Dose (RfD) for lindane is 0.0003 milligram per kilogram body weight per day (mg/kg/d) based on liver and kidney toxicity in rats. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur. (5)
- EPA has medium confidence in the principal study on which the RfD was based because it used an adequate number of animals and measured multiple endpoints; confidence in the database is medium because there are other reported chronic and subchronic studies; and, consequently, medium confidence in the RfD. (5)
- EPA has not established a Reference Concentration (RfC) for lindane. (5)
- The California Environmental Protection Agency (CalEPA) has calculated a chronic inhalation reference exposure level of 0.0003 milligrams per cubic meter (mg/m<sup>3</sup>) based on kidney effects in rats. The CalEPA reference exposure level is a concentration at or below which adverse health effects are not likely to occur. (7)

#### Reproductive/Developmental Effects:

- Limited information is available regarding the reproductive or developmental effects of lindane in humans. The one available study reported increased levels (not statistically significant) of follicle stimulating hormone and decreased levels of testosterone in men occupationally exposed to lindane. It is not known whether these hormonal changes could result in diminished reproductive capability. (1)
- Animal studies have reported reproductive effects, such as decreased sperm count, increased testicular weight, and disruption of spermatogenesis from oral exposure to lindane. Disrupted ovarian cycling and reduced ovulation rate were reported in female animals exposed to lindane by gavage (experimentally placing the chemical in the stomach). (1,3)
- Lindane has not been reported to cause developmental effects, such as birth defects, in animals via oral exposure. (1,3)

#### Cancer Risk:

- No studies are available concerning carcinogenic effects in humans or animals following inhalation exposure to lindane. (1)
- Lindane has been demonstrated to be a liver carcinogen in mice via oral exposure. (1)
- EPA considers lindane to be a possible human carcinogen (cancer-causing agent) and has ranked it in EPA's Group B2/C. (6)
- EPA has established an oral cancer slope factor of  $1.3 \text{ (mg/kg/d)}^{-1}$ . (6)
- CalEPA has calculated an inhalation unit risk factor of  $3.1 \times 10^{-4} \text{ (}\mu\text{g/m}^3\text{)}^{-1}$ . (8)

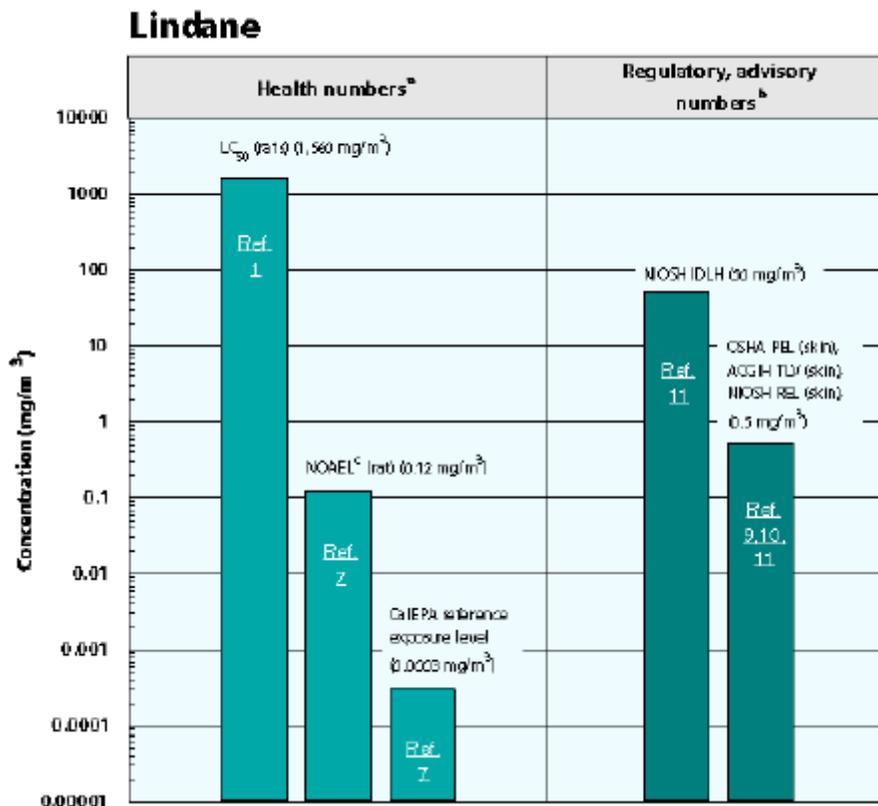
# Physical Properties

- Lindane is the common name for gamma-hexachlorocyclohexane. (1,5)
- The chemical formula for lindane is C<sub>6</sub>H<sub>6</sub>Cl<sub>6</sub>, and it has a molecular weight of 290.83 g/mol. (1)
- Lindane is a white crystalline solid that is volatile in air and insoluble in water. (1)
- Lindane vapor is colorless and has a slight musty odor; the odor threshold is 12 parts per million (ppm).
- (1) The vapor pressure for lindane is  $9.4 \times 10^{-6}$  mm Hg at 20 °C, and it has a log octanol/water partition coefficient (log K<sub>ow</sub>) of 3.3. (1)

## Conversion Factors:

To convert concentrations in air (at 25 °C) from ppm to mg/m<sup>3</sup>:  $\text{mg/m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$ . For lindane: 1 ppm = 11.89 mg/m<sup>3</sup>. To convert concentrations in air from µg/m<sup>3</sup> to mg/m<sup>3</sup>:  $\text{mg/m}^3 = (\mu\text{g/m}^3) \times (1 \text{ mg} / 1,000 \mu\text{g})$ .

## Health Data from Inhalation Exposure



ACGIH TLV --American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

LC<sub>50</sub> (Lethal Concentration<sub>50</sub>)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

NIOSH REL --National Institute of Occupational Safety and Health's recommended exposure limit; NIOSH--recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.

NIOSH IDLH -- NIOSH's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.

NOAEL--No observed adverse effect level.

OSHA PEL --Occupational Safety and Health Administration's permissible exposure limit expressed as a time-

weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

The health and regulatory values cited in this factsheet were obtained in December 1999.

<sup>a</sup> Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

<sup>b</sup> Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH and ACGIH numbers are advisory.

<sup>c</sup> The NOAEL is from the critical study used as the basis for the CalEPA inhalation reference exposure level.

## References

Summary created in April 1992, updated January 2000

1. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Alpha-, Beta-, Gamma-, and Delta- Hexachlorocyclohexane (Update). Draft for Public Comment. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1997.
2. U.S. Environmental Protection Agency. [Deposition of Air Pollutants to the Great Waters](#). First Report to Congress. EPA-453/R-93-055. Office of Air Quality Planning and Standards, Research Triangle Park, NC. 1994.
3. U.S. Department of Health and Human Services. Hazardous Substances Databank ([HSDB, online database](#)). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
4. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, [online database](#)). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
5. U.S. Environmental Protection Agency. [Integrated Risk Information System \(IRIS\) on gamma-Hexachlorocyclohexane](#). National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999.
6. U.S. Environmental Protection Agency. Health Effects Assessment Summary Tables. FY 1997 Update. Solid Waste and Emergency Response, Office of Emergency and Remedial Response, Cincinnati, OH. EPA/540/R-97-036. 1997.
7. [California Environmental Protection Agency \(CalEPA\)](#). Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. Draft for Public Comment. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1997.
8. [California Environmental Protection Agency \(CalEPA\)](#). Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II. Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1999.
9. Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Standards, Toxic and Hazardous Substances. Code of Federal Regulations 29 CFR 1910.1000. 1998.
10. American Conference of Governmental Industrial Hygienists (ACGIH). 1999 TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents. Biological Exposure Indices. Cincinnati, OH. 1999.
11. National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Cincinnati, OH. 1997.