

chemicalWATCH Factsheet

Permethrin

Background info:

Permethrin is in a class of compounds known as synthetic pyrethroids. Synthetic pyrethroids are synthesized derivatives of naturally occurring pyrethrins, which are taken from extracts of dried chrysanthemum flowers.¹ Synthetic pyrethroids are more stable than natural pyrethroids, and therefore longer lasting in the field.² Although synthetic pyrethroids are often thought of as “safe as chrysanthemums,” they are chemically engineered to be more toxic than natural pyrethroids.³ Permethrin is widely used as an insecticide in agriculture, homes and gardens, and for treatment of ectoparasites (fleas, lice, scabies) on humans and animals.⁴ Worldwide, the dominant use of permethrin is for cotton, which accounts for over 60% of the permethrin used.⁵ In the U.S., almost 70% of the permethrin used in agriculture is used on corn, wheat, and alfalfa.⁶ Annually, over 100 million applications of permethrin are made each year in and around U.S. homes.⁷ Some common products containing permethrin as the active ingredient include: Nix, Elimite, Prelude, Combat, Ambush, Dragnet, Outflank, Pounce, Perthrine, Picket, and Astro. Permethrin comes in many forms, including sprays, dusts, fogs, emulsifiable concentrates, and creams. Additionally, in 2003, the EPA approved permethrin-impregnated clothing for public use.⁸

Like all synthetic pyrethroids, Permethrin kills insects by strongly exciting their nervous system, a similar mode of action to DDT.⁹ In terms of its chemical arrangement, permethrin has four isomers. Isomers are molecules that have the same molecular formula, but have a different arrangement of the atoms in space. On permethrin, the *cis*

isomers are the most insecticidally active and therefore the most toxic.¹⁰ The half-life of permethrin in soil is 30 days, although it is less in soil with more organic matter in it. The half-life on foliage is 10 days.¹¹ The *trans*-isomer has been shown to degrade more rapidly than the more toxic *cis*-isomer.¹² Permethrin for agricultural uses is classified as a “Restricted Use” pesticide. Restricted Use pesticides are limited to licensed pesti-

toxicity is to the central nervous system, and seizures have been reported in severe cases of pyrethroid intoxication. However, according to the EPA, there are no reports of seizures in humans from exposure to Permethrin.¹⁷ At relatively high doses, neurotoxic symptoms in mammals include tremors, loss of coordination, hyperactivity, paralysis, and an increase in body temperature.¹⁸

Chemical Class: Synthetic Pyrethroids

Use: Insecticide- for humans, animals, and agriculture; used to control mosquitoes, termites, roaches, ants, ticks, fleas, chiggers, lice, and scabies

Toxicity: Class II or III; moderately to practically non-toxic; a skin and eye irritant

Signal Word: Warning or Caution

Carcinogenicity: Class C, possible human carcinogen

Long-term Health Effects: Suspected Endocrine Disruptor, immunotoxin, neurotoxin, reproductive effects

Environmental Effects: Highly toxic to fish, aquatic animals, and bees

The LD₅₀ (the lethal dose that kills 50 percent of a population of test animals) for permethrin is variable, ranging from 430-mg/kg body weight to over 4,000 mg/kg for rats.¹⁹ Some of this variability is due to varying proportions of isomers; the *trans*-isomers are hydrolyzed more readily and have a significantly lower toxicity in rats than do the corresponding *cis*-isomers,²⁰ which are around 10 times more toxic than the *trans*-isomers.²¹ For example, the female acute oral LD₅₀ of permethrin increases from around 220 mg/kg to 6000 mg/kg as the proportion of the *trans* isomer increases from 20% to 80% of the solution.²²

cide applicators or their employees, and only for the uses covered by the applicators certification or on the pesticide label.¹³ However, permethrin products labeled for spot treatments or other over the counter products are not restricted use.¹⁴

Acute Toxicity

According to the U.S. EPA, permethrin is a moderately to practically non-toxic pesticide, and falls into either toxicity class II or III, depending on the formulation. Products containing permethrin must bear the signal word WARNING or CAUTION.¹⁵ Permethrin may be readily absorbed from the gastrointestinal tract, minimally through intact skin, and by inhalation of dust and spray mist.¹⁶ The most severe synthetic pyrethroid

Human Toxicity:

For humans, acute toxicity is fairly low, producing symptoms mainly of irritation. Permethrin can be irritating to both the eyes and the skin.²³ Occupational exposure to permethrin has caused skin sensations that include itching, burning, and numbness, and irritative symptoms in the eyes and upper respiratory tract.²⁴ To assess the human tolerance, absorption, and persistence of permethrin when used against human lice, 10 adult volunteers were treated with permethrin head louse solution. Three of them developed mild, patchy erythema, which lasted for a few days.²⁵ Additionally, synthetic pyrethroids



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have been shown to be respiratory allergens and use of them may result in asthma-like symptoms, especially in children with a history of asthma or allergies.²⁷ Besides asthma, other allergic respiratory responses to permethrin can include sneezing, asthma, sinusitis, and bronchitis.²⁸

Animal Toxicity:

Many flea and tick treatments for dogs contain permethrin as their active ingredient. “Spot-On” treatments especially contain large quantities of permethrin (45-65%). Even small amounts of this can be quite toxic and even fatal to cats. Exposure to cats often occurs accidentally from contact with dogs being treated with permethrin.²⁹ There have also been reports of dogs being poisoned by these treatments; on one site on the Internet, people give experiences with various Flea and Tick Remedies, including Biospot. The site lists hundreds of stories of people who have used these permethrin-containing products on their cats and dogs and had adverse reactions—mostly seizures, vomiting, behavioral changes, and death.³⁰

Childhood Susceptibility

Children may be more sensitive to permethrin than adults: a study found that permethrin is almost 5 times more toxic to 8 day old rats than to adult rats due to incomplete development of the enzymes which break down pyrethroids in the liver.³¹ Additionally, studies on newborn mice have shown that permethrin may inhibit neonatal brain development.³²

Long-term Health Effects

Cancer:

At the time of EPA’s last evaluation of the carcinogenic potential of permethrin in 1989, they classified permethrin as Group C—a Possible Human Carcinogen.³³ The World Health Organization reported that permethrin increased the frequency of lung tumors in female mice in 2 out of 3 studies that it reviewed.³⁴ In a study on the effects of permethrin on breast cancer cells, researchers found that permethrin increases the expression of a gene that is involved with proliferation of cells in the mammary gland.³⁵

Permethrin has also been linked to prostate cancer; in a study of farmers and professional pesticide applicators, permethrin was shown to increase the risk of prostate cancer in men with a family history of prostate cancer.³⁶

Immune System Effects:

Ingestion of even small doses of permethrin has been shown to reduce the ability of immune system cells to recognize and respond to foreign proteins. Doses equivalent to 1/100 of the LD₅₀ inhibited T-lymphocytes and natural killer cells by over 40%.³⁷ In a study that applied varying doses of permethrin to shaved regions of mice, researchers found that dermal absorption caused antibody production to significantly decrease. The study concluded that low-level topical permethrin exposure may produce systemic immunotoxicity.³⁸ A follow-up study found that exposure to sunlight worsened this response.³⁹

Effects on Reproduction:

Permethrin affects both male and female reproductive systems.⁴⁰ EPA lists permethrin as a suspected endocrine disrupter.⁴¹ Permethrin binds to receptors for androgen (a male sex hormone) in cells from human males.⁴² It also binds to the peripheral benzodiazepine receptor, which stimulates production of testosterone.⁴³ In a long-term feeding study of mice, permethrin was shown to cause reduced testes weights.⁴⁴ In another study, researchers found that permethrin had significant estrogenic potency as it inhibited the binding of estradiol to the estrogen receptor.⁴⁵

Mutagenicity:

While some tests on hamster cells and on salmonella have shows permethrin to be non-mutagenic,⁴⁶ permethrin was found to have mutagenic effects in three tests with human cell cultures, one with hamster cells, and one with fruit fly larvae. In the human cell cultures, permethrin exposure caused an increase in chromosome aberrations, chromosome fragments, and DNA lesions.⁴⁷

Neurotoxicity:

In a study on pesticide exposure and the Gulf War syndrome, researchers found that

application of permethrin to adult rats led to neuronal cell death in various parts of the brain, which could lead to motor deficits and learning and memory dysfunction. These results led the researchers to conclude, “it is likely that subchronic [dermal] exposure to DEET and permethrin experienced by service personnel during the Persian Gulf War has played an important role in the development of illnesses in some veterans after the Gulf War.”⁴⁸ Another study found that low levels of permethrin were related to lower dopamine production and increased levels of the protein alpha-synuclein. Both of these changes are consistent with a pre-Parkinson’s condition, although not necessarily the full-blown disease.⁴⁹

Other Chronic effects:

In 17 medium and long-term studies performed by the EPA that exposed rats, mice, and dogs to permethrin, all the studies noted effects on the liver even at the lowest levels of permethrin.⁵⁰ Other chronic effects include enlarged adrenal glands (in a rabbit feeding study) and increased kidney weights (in a rat feeding study).⁵¹ Permethrin may also be linked to pediatric brain tumors. The findings of a 1997 study indicate that chemicals used in flea/tick products may increase risk of pediatric brain tumors. Permethrin is one of the most commonly used chemicals in flea and tick products.⁵²

Residues on food:

The FDA’s monitoring program routinely finds permethrin on food. In 1996, the found that permethrin was the 13th most commonly detected pesticide on food.⁵³ In 2001, it was the 8th most commonly detected pesticide on food, and the 7th most commonly detected pesticide on baby food.⁵⁴

Environmental Effects

Permethrin is highly toxic to fish, due to the sensitivity of their nervous systems. It is also highly toxic to many aquatic invertebrate animals; its effects on insects and crustaceans are particularly severe. Permethrin is practically non-toxic to birds, although there may be some long-term effects.⁵⁵ Some endangered toads and salamanders may also be at risk from permethrin.⁵⁶ Permethrin nega-



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tively affects many species of beneficial arthropods (those arthropods that are useful in agriculture). For example, permethrin is extremely acutely toxic to honey bees, even at very low doses.⁵⁷ Although it is commonly thought that the potential for leaching into water is low because permethrin adsorbs strongly to soil particles and has a short half-life in water,⁵⁸ the U.S. Geological Survey has found permethrin in ground and surface water in numerous locations.⁵⁹ Furthermore, a very recent study of pesticides in bodies of water in the agriculture-dominated Central Valley in California found high levels of synthetic pyrethroids in stream sediments—levels high enough that they were toxic to freshwater bottom dwellers in almost 50% of the sampled locations.

Permethrin was the most commonly detected pesticide in the study.⁶⁰

Regulatory Status and History

Permethrin was first marketed in 1977 for use on cotton. In October 1982, EPA began to allow an expansion of permethrin registrations to include use on livestock, poultry, eggs, vegetables, and fruit—a 500% expansion of the market for permethrin.⁶¹ This decision was quite controversial, and was opposed by EPA staff pathologist, M. Adrian Gross, who argued that permethrin presents an intolerable statistical risk of causing cancer.⁶² This controversy largely focused on the results and validity of the original EPA tests on permethrin. EPA's of-

ficial stance at the time was that permethrin was not a carcinogen. John A. Todhunter, the assistant administrator for pesticides and toxic substances at the time, wrote that, "The likelihood of oncogenic effects in humans from exposure to low levels of permethrin is nonexistent or extremely low."⁶³ However, Dr. Adrian Gross dissented on the EPA's evaluation, bringing to their attention that the Allowable Daily Intake of 0.05 mg/kg body weight/day was associated with cancer rates as high as between 5-10% of the population! He wrote, "I should think that risks of cancer of this order for a relatively new insecticide are unacceptable to any rational person."⁶⁴ However, permethrin is not scheduled for re-registration until June 2006.

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