



PUBLIC HEALTH STATEMENT PYRETHRINS and PYRETHROIDS

Division of Toxicology

September 2003

This Public Health Statement is the summary chapter from the Toxicological Profile for Pyrethrins and Pyrethroids. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about pyrethrins and pyrethroids and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Pyrethrins and pyrethroids have been found in at least 5 and 2 of the 1,636 current or former NPL sites, respectively. However, the total number of NPL sites evaluated for these substances is not known. As more sites are evaluated, the sites at which pyrethrins and pyrethroids are found may increase. This information is important because exposure to these substances may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in

contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to pyrethrins and pyrethroids, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with them. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT ARE PYRETHRINS AND PYRETHROIDS?

Pyrethrum is a naturally occurring mixture of chemicals found in certain chrysanthemum flowers. Pyrethrum was first recognized as having insecticidal properties around 1800 in Asia and was used to kill ticks and various insects such as fleas and mosquitos. Six individual chemicals have active insecticidal properties in the pyrethrum extract, and these compounds are called pyrethrins. Pyrethrum looks like a tan-colored dust as ground flowers or a syrupy liquid as the crude extract. Pyrethrins are only slightly soluble in water, but they dissolve in organic solvents like alcohol, chlorinated hydrocarbons, and kerosene. Pyrethrins are often used in household insecticides and products to control insects on pets or livestock. Pyrethrins break down quickly in the environment, especially when exposed to natural sunlight.

Pyrethroids are manufactured chemicals that are very similar in structure to the pyrethrins, but are often more toxic to insects, as well as to mammals, and last longer in the environment than pyrethrins. More than 1,000 synthetic pyrethroids have been developed, but less than a dozen of them are currently used in the United States. Pyrethrins and

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pyrethroids are often combined commercially with other chemicals called synergists, which enhance the insecticidal activity of the pyrethrins and pyrethroids. The synergists prevent some enzymes from breaking down the pyrethrins and pyrethroids, thus increasing their toxicity.

Most commercial pyrethroids are not one single molecule; rather, they are several molecules with the same chemical formula that have their atoms joined together in the same sequence, but have a different arrangement of the atoms in space. Such compounds are called stereoisomers. If the stereoisomers are not mirror images of one another, they are called diastereomers and have different physical properties like boiling point, melting point, and solubility. If they are nonsuperimposable mirror images of each other, they are called enantiomers and properties like boiling point, melting point, and solubility are identical. However, both diastereomers and enantiomers can have different insecticidal properties and different toxicities. Some pyrethroids are composed of as many as eight different stereoisomers.

Technical-grade (concentrated) pyrethrins and pyrethroids are usually mixed with carriers or solvents to produce a commercial-grade formulated product. The formulated product contains many inert ingredients that can increase the toxicity of the product when compared to the technical-grade material. By law, the active ingredient must be identified by name on the pesticide label and its percentage must be provided. Nonactive ingredients (sometimes called inert ingredients) do not need to be identified by name on a pesticide label, only the percentage of nonactive ingredients must be specified, so it is often difficult to determine what

other chemicals are included in the final formulated product.

1.2 WHAT HAPPENS TO PYRETHRINS AND PYRETHROIDS WHEN THEY ENTER THE ENVIRONMENT?

Pyrethrins and pyrethroids are primarily released to air because of their use as insecticides. Sometimes they are sprayed on crops from planes and helicopters or sprayed from the ground by trucks, tractors, or hand-held applicators. They are also used to control flying insects like mosquitos and flies on livestock and pets. These compounds are also in aerosol bombs and sprays that can be used indoors. Pyrethrins can be released naturally from chrysanthemum flowers, but these releases are small compared with the amounts used as commercial insecticides. Manufacturing facilities that produce these compounds can also release them to the environment during the production process.

In air, all six of the pyrethrins and many of the pyrethroids are broken down or degraded rapidly by sunlight or other compounds found in the atmosphere. Often, they last only 1 or 2 days before being degraded. Rain and snow help remove the pyrethroids from air that are not rapidly degraded. Since many of these compounds are extremely toxic to fish, they are usually not sprayed directly onto water, but they can enter lakes, ponds, rivers, and streams from rainfall or runoff from agricultural fields. These compounds bind strongly to dirt and usually are not very mobile in soil. Pyrethrins and pyrethroids are not easily taken up by the roots of plants and vegetation because they are strongly bound to the soil; however, they are often sprayed directly onto crops and plants so they may be found

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on leaves, fruits, and vegetables. Because these compounds adsorb so strongly to soil, pyrethrins and pyrethroids usually do not leach into groundwater, do not contaminate drinking water supplies, and volatilize from soil surfaces slowly. These compounds are eventually degraded by the microorganisms in soil and water. They can also be degraded by sunlight at the surfaces of water, soil, or plants. However, some of the more recently developed pyrethroids can persist in the environment for a few months before they are degraded.

1.3 HOW MIGHT I BE EXPOSED TO PYRETHRINS AND PYRETHROIDS?

You can be exposed to pyrethrins and pyrethroids in several ways. Eating foods that are contaminated with these compounds is the most likely way. You can also breathe in air that contains these compounds. This is especially possible soon after the insecticide has been sprayed. After spraying, these compounds can also come in contact with your skin and you can be exposed by dermal contact. These compounds are contained in many household insecticides, pet sprays, and shampoos. Some pyrethroids are also used as lice treatments that are applied directly to the head and as mosquito repellents that can be applied to your clothes. A common treatment for scabies is the application of a pyrethroid to the affected skin surface excluding the scalp. The use of these products can lead to exposure.

The average daily intake of permethrin (the most frequently used pyrethroid in the United States) for a 70 kilogram adult male is estimated as about 3.2 micrograms per day (1 microgram equals 1/1,000,000 of a gram). This value is about 1,000

times less than the acceptable daily intake (ADI) of permethrin derived by the United Nations' Food and Agriculture Organization (FAO) and the World Health Organization (WHO).

1.4 HOW CAN PYRETHRINS AND PYRETHROIDS ENTER AND LEAVE MY BODY?

Pyrethrins and pyrethroids usually enter the body when people eat foods contaminated by these chemicals. They may also enter your body by breathing air that contains these compounds or through dermal exposure when you use commercially available insecticides that contain pyrethrins and pyrethroids. These chemicals are absorbed by the body when you eat contaminated foods and breathe contaminated air, but they are not as easily absorbed through the skin when you touch contaminated soil, vegetation, or insecticides containing these compounds. Some insect repellents that are applied to the skin contain pyrethrins or pyrethroids in addition to another chemical called DEET, which may allow the pyrethrins or pyrethroids to enter your body more easily. Pyrethrins and pyrethroids can enter your body if you swallow drinking water contaminated with these compounds, but since pyrethrins and pyrethroids are rarely found in drinking water, this will be a minor exposure route. Accidental exposures to pyrethrins or pyrethroids may also occur if these pesticides are improperly used.

Pyrethrins and pyrethroids that enter the body leave quickly, mainly in the urine, but also in feces and breath. These compounds are also quickly broken down by the body into other chemicals called metabolites. The concentration of these chemicals in the urine increases as the amount of the exposure

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goes up. If exposure levels are very high or if exposure occurs over a long time, then pyrethrins and pyrethroids can build up in fatty tissue and remain in the body for a little longer. Certain types of pyrethroids can also be retained for longer periods of time in the skin and hair.

1.5 HOW CAN PYRETHRINS AND PYRETHROIDS AFFECT MY HEALTH?

Pyrethrins and pyrethroids interfere with the way that the nerves and brain function. If you get a large amount of pyrethrins or pyrethroids on your skin, you may get feelings of numbness, itching, burning, stinging, tingling, or warmth that could last for a few hours. You are not likely to be exposed to amounts of pyrethrins or pyrethroids by breathing air, eating food, or touching anything that would cause enough pyrethrins or pyrethroids to enter your body and cause other problems. But if very large amounts of these chemicals were to enter your body, you might experience dizziness, headache, and nausea that might last for several hours. Larger amounts might cause muscle twitching, reduced energy, and changes in awareness. Even larger amounts could cause convulsions and loss of consciousness that could last for several days. Allergic reactions have been seen in a few individuals who used products that contain pyrethrins or pyrethroids. There is no evidence that pyrethrins or pyrethroids cause birth defects in humans or affect the ability of humans to produce children. There is evidence from animal studies that pyrethrins and pyrethroids might be capable of causing cancer in people, but the evidence comes from animals that ate very large amounts of pyrethrins or pyrethroids for a lifetime.

To protect the public from the harmful effects of

toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Animal studies show effects of pyrethrins and pyrethroids similar to those seen in people exposed to very high amounts of these chemicals. In addition, exposure to pyrethrins or pyrethroids might affect the ability of some animals to reproduce and may also cause cancer.

1.6 HOW CAN PYRETHRINS AND PYRETHROIDS AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children exposed to large amounts of pyrethrins or pyrethroids would be expected to be affected in the same manner as adults. If children were to get a large amount of pyrethrins or pyrethroids on their skin, they might get feelings of numbness, itching, burning, tingling, or warmth that could last for a few hours. If very large amounts of these chemicals were to enter a child's body, the child might

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experience dizziness, headache, and nausea that might last for several hours. Even larger amounts could cause muscle twitches, tremors, convulsions, and loss of consciousness that could last up to several days.

Pyrethroids might be able to penetrate the skin of infants and young children more easily than the skin of adults. Infants and young children are more easily dehydrated than adults through exercise, flue, colds, and the conditions that contribute to fluid loss. Therefore, pyrethroids that penetrate the skin may become more concentrated in internal tissues of the young.

There is no evidence in humans that pyrethrins or pyrethroids cause birth defects. Some young animals showed signs of possible damage to the body's defense system that fights infection after their mothers were exposed to pyrethroids while their babies were developing in the womb. There is some indication that the developing brain of some very young animals could be affected by pyrethroids.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO PYRETHRINS AND PYRETHROIDS?

If your doctor finds that you have been exposed to significant amounts of pyrethrins or pyrethroids, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

Pyrethrins and pyrethroids are effective insecticides that are often used in household sprays, aerosol bombs, insect repellents, pet shampoos, and lice treatments. Using products containing these

compounds will expose you to these chemicals. If you decide to use these products, carefully follow the instructions on how to apply them properly and how long to wait before re-entering the treated area. Do not apply more than the recommended amount. Pesticides and household chemicals should be stored out of reach of young children to prevent accidental poisoning. Always store pesticides in their original labeled containers; never store pesticides in containers that young children would find attractive, such as old soda bottles. If you feel sick after a pesticide has been used in your home, call the local poison control center or see a doctor. Keep your poison control center's number next to the phone. If a close neighbor or someone living nearby is applying pyrethrins or pyrethroids, you may want to remain indoors with your children and pets in order to avoid being accidentally exposed to these chemicals. Certain pyrethroids, such as permethrin, phenothrin, and resmethrin, are sprayed to control mosquitos during the spring and summer. Remaining indoors and closing your windows while your neighborhood is being sprayed will lessen your exposure.

Since these compounds frequently are used on crops, they are often detected in fruits and vegetables. Make sure you wash fruits and vegetables thoroughly before eating them. Trim the fat from meat and poultry because pesticides often concentrate in fat. These compounds are often detected in soils, especially in agricultural areas. Some children eat a lot of dirt. You should discourage your children from eating dirt. Make sure they wash their hands frequently and before eating. Discourage your children from putting their hands in their mouths or any other hand-to-mouth activity.

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1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO PYRETHRINS AND PYRETHROIDS?

Methods exist that can detect pyrethrins and pyrethroids in blood and urine. Because these compounds are broken down in the body quickly, there are also ways to measure the metabolites of these chemicals in human blood and urine. These methods are not available in a doctor's office because special equipment is required. However, a sample taken in a doctor's office can be shipped to a special medical laboratory, if necessary. These laboratories are usually located at research universities or affiliated with government agencies such as the Centers for Disease Control and Prevention (CDC). Your doctor may need to contact the county health department for a list of laboratories that can perform these tests. Because pyrethrins and pyrethroids break down in the body rapidly, these methods are useful only if exposure has occurred within the last few days. At this time, these methods can tell only if you have been exposed to pyrethrins or pyrethroids and cannot tell if you will have any adverse health effects. Methods also exist that can measure the concentration of pyrethrins and pyrethroids in air, water, soil, and foods.

For pesticide emergencies, the National Pesticide Information Center (NPIC) (formerly called the National Pesticide Telecommunications Network [NPTN]) located at Oregon State University, is also available. The NPIC (telephone number: 1-800-858-7378 for the general public and 1-800-858-7377 for medical profession/government agencies) provides information about pesticides to anyone in the United States.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for pyrethrins and pyrethroids include the following:

The WHO has recommended that the level of permethrin in drinking water not exceed 20

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micrograms per liter ($\mu\text{g/L}$). OSHA regulates the level of pyrethrins in workplace air. The occupational exposure limits for an 8-hour workday, 40-hour workweek are 5 mg per cubic meter (mg/m^3). The EPA has recommended daily oral exposure limits for 10 different pyrethroids. These limits range from 0.005 to 0.05 mg/kg/day.

In September of 1997, the EPA issued a request to pesticide formulators to voluntarily change the term "inert ingredients" to "other ingredients" on pesticide labels because the general public often believed that inert ingredients meant harmless ingredients. Since federal law does not define inert ingredients on the basis of toxicity or hazard to humans, it should not be assumed that all inert ingredients are nontoxic. The EPA publishes a list of all inert ingredients used in currently registered pesticides, but it does not specify which ingredients are contained in any specific formulated product.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop F-32
Atlanta, GA 30333

Information line and technical assistance:

Phone: 888-422-8737
FAX: (770)-488-4178

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847 or 703-605-6000

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. Toxicological profile for pyrethrins and pyrethroids. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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