The Facts about Mothballs[1]

Fred Fishel[2]

Lately, Joe had seen several mice in his kitchen and heard them in his attic during the night. A neighbor recommended that mothballs would control the mice problem. Taking the neighbor's advice, Joe scattered several boxes of mothballs throughout his kitchen and attic. The next morning, Joe's wife Anne awoke to a pungent aroma throughout the house, making breathing difficult, along with a headache that would not go away.

Anne later learned that her situation could have been avoided if Joe had read and followed the label directions. Joe had used a mothball product that was not registered by the US Environmental Protection Agency (EPA) to repel or kill mice. Rather, it was intended to kill clothes moths and their eggs and to be used only in garment bags, storage closets, and airtight containers.

Figure 1. Mothballs are formulated as solids.
Credits: F. M. Fishel, UF/IFAS

What do mothball products contain?

Mothballs, moth flakes, crystals, and bars are insecticides that are formulated as solids (Figure 1). As such, mothballs are registered as pesticides because they contain high concentrations of one of two active ingredients—naphthalene (Figure 2) or paradichlorobenzene (sometimes referred to as 1,4-dichlorobenzene). Through sublimation, they exude gas, acting as a fumigant. Paradichlorobenzene is also found in deodorant blocks made for trash cans and toilets.

Figure 2. Product containing 99.95% naphthalene.
Credits: F. M. Fishel, UF/IFAS

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Since they are registered as pesticides, how are mothballs regulated?

They are regulated in the United States by the EPA and the Florida Department of Agriculture and Consumer Services (FDACS). There are currently more than 30 products registered with the US EPA that contain paradichlorobenzene and more than a dozen products that contain naphthalene. The label of any pesticide, including mothballs, specifies exactly where and how to legally use the product. Using mothballs in a way not specified by the label is not only illegal but can harm people, pets, or the environment. In Florida, FDACS receives consumer complaints and investigates the misuse of mothballs on a regular basis. The majority of misuse involves the outdoor use of mothballs to repel snakes and other nuisance wildlife. There are snake and wildlife repellents available at retail stores that contain naphthalene; however, mothball products are not approved for such use and can result in harm to children, pets, and other animals.

Always read the product label first before using a pesticide product in order to determine where it can be used, what pests the product will control, and how to use it correctly. Mothball containers typically direct the user to place mothballs in a tightly closed container that will prevent the pesticide fumes from accumulating in living spaces where people and pets can breathe them in for long periods of time. Inside the airtight containers, the vapors released by the mothballs build up and kill the clothes moths.

Are there harmful health effects caused by mothballs?

They can harm people, pets, or wildlife that may touch or eat the mothballs or that may breathe the vapors. Humans are most likely to be exposed to either paradichlorobenzene or naphthalene by breathing in the vapors. Small children and pets are at risk of eating mothballs, because they look like candy or other treats. One mothball can cause serious harm if eaten by a small child.

Naphthalene is produced when things burn, so naphthalene is found in cigarette smoke, car exhaust, and smoke from forest fires. Once naphthalene enters the human body, it is broken down to alpha-naphthol, which is linked to the development of hemolytic anemia, the abnormal breakdown of red blood cells. As a result, oxygen can no longer be carried as it should. Kidney and liver damage may also occur. Alpha-naphthol and other metabolites are excreted in urine.

In humans, paradichlorobenzene is distributed in the blood, fat, and breast milk. It is broken down into several other chemicals by the body and excreted in urine. The World Health Organization (WHO) considered paradichlorobenzene possibly carcinogenic to humans based on studies with mice (World Health Organization 2009). The US EPA has classified it as "not likely to be carcinogenic to humans."

What are signs and symptoms from exposure to paradichlorobenzene and naphthalene?

People have developed headaches, nausea, dizziness, and/or vomiting after being exposed to naphthalene vapors. If someone breathes in enough of the vapor or eats a mothball containing naphthalene, they might develop hemolytic anemia. Small children have also developed diarrhea, fever, abdominal pain, and painful urination with discolored urine after eating naphthalene. Dogs that have eaten naphthalene mothballs may have lethargy, vomiting, diarrhea, lack of appetite, and tremors.

People who have been exposed to paradichlorobenzene have experienced nausea, vomiting, dizziness, fatigue, and headaches. Its vapor can also irritate the eyes and nasal passages. If paradichlorobenzene contacts the skin for a prolonged period, it can cause a burning sensation. If a pet eats a mothball made of paradichlorobenzene, they may have vomiting, tremors, and/or abdominal pain. Paradichlorobenzene may also cause kidney and liver damage in pets.

If someone has swallowed a mothball, call the Poison Control Center at 1-800-222-1222 for emergency medical advice. If a pet is suspected of eating a mothball, contact a veterinarian.

What happens to naphthalene and paradichlorobenzene in the environment?

Most of these chemicals will turn into a gas. In air, the half-life of naphthalene and paradichlorobenzene is less than one day and about 31 days, respectively.

Some naphthalene may be bound to soil, where it can be taken up by plants. It can also be deposited on plant leaves from the air. Naphthalene is broken down by bacteria, fungi, air, and sunlight. There is no information available on naphthalene and groundwater, although it is not very soluble in water. Naphthalene is considered moderately toxic to several species of fish, water fleas, and Pacific oysters. It is considered slightly toxic to green algae. Naphthalene is considered practically non-toxic after being fed to bobwhite quail.

Paradichlorobenzene that binds to soil may be taken up by plants, and plant leaves may absorb it from the air. Paradichlorobenzene has been found in rainwater and snow and in groundwater close to a source of contamination. It is considered moderately to low in toxicity to fish, with differences in sensitivity by species. There is no information available for paradichlorobenzene's effects on bees.

Conclusion

Naphthalene and paradichlorobenzene, the active ingredients in mothballs, are registered as pesticides. As such, their label directions carry the force of the law, including use intent and the sites where they may legally be used. Using mothballs with the intent of repelling various forms of wildlife is not a legal use of these materials and can result in penalties. Always read and follow pesticide label directions.

Additional Information

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