

What is piperonyl butoxide (PBO)?

Piperonyl butoxide (PBO) is a man-made pesticide [synergist](#). By itself, PBO is not designed to harm insects. Instead, it works with bug killers to increase their effectiveness. PBO is often combined with natural [pyrethrins](#) or man-made [pyrethroids](#). It has been used in pesticide products since the 1950s, when it was first registered in the United States.



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What are some products that contain piperonyl butoxide (PBO)?

There are more than 2,500 pesticide products that contain the active ingredient PBO. These include foggers, dusts, and sprays. Some of these products may be used inside and outside of homes. PBO is also used on agricultural crops and livestock. Other uses include [mosquito](#) control programs and [flea](#) and [tick](#) treatments for pets.

Some [head lice](#) products contain PBO and may be applied to humans as lotions or shampoos. The United States Food and Drug Administration regulates products used to control head lice on people. These products are not considered pesticides.

Always [follow label instructions](#) and take steps to minimize exposure. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to [discuss a pesticide problem](#), please call 1-800-858-7378.

How does piperonyl butoxide (PBO) work?

PBO is not designed to kill insects by itself. Insects have enzymes in their bodies that break down some insecticides. PBO stops some of these enzymes and allows insecticides more time to work. This means insects are less likely to recover from the combination of PBO and certain [insecticides](#).

Early studies found that PBO greatly improved how well pyrethrins kill houseflies. PBO itself did not kill the flies. The combination of both allowed more control with smaller amounts of pyrethrins.

How might I be exposed to piperonyl butoxide (PBO)?

You may be exposed to PBO by breathing it, eating it, touching it, or getting it in your eyes. This can happen when applying sprays or dusts indoors or outdoors. Avoid touching wet surfaces or inhaling pesticide mist or dust. You may also be exposed if you eat, smoke, or use the bathroom without washing your hands after a pesticide application. PBO is also registered for use on both dogs and cats in flea and tick treatments. People may be exposed while treating their pets or if they touch a recently treated pet.

Very small amounts of PBO may be present as residue found on food. PBO is approved for use on many crops before harvest. It is exempt from [maximum residue limit](#) (tolerance) requirements. Some foods may be treated with PBO after harvest, including almonds, tomatoes, wheat, and animal meat.

What are some signs and symptoms from a brief exposure to piperonyl butoxide (PBO)?

It is rare for people to be exposed to PBO alone because it is always combined with at least one insecticide. PBO is low to very low in toxicity if eaten, inhaled, or touched. PBO is slightly irritating if it gets in the eyes or on skin. It does not produce skin allergies.

In one study, rats inhaled very large doses of PBO for four hours. Symptoms included tearing, drooling, runny nose, and difficulty breathing. In another study, rats were fed one large dose of PBO. Effects included lower appetite, unsteady balance, watery eyes, irritable behavior, coma, and death. Human volunteers were given a small dose of PBO to test effects on the liver. The PBO did not weaken their livers.

See [NPIC fact sheets](#) for signs and symptoms of exposure to other pesticides that may be mixed with PBO. Pesticide ingredients may include [pyrethrins](#) or [pyrethroids](#) such as [permethrin](#), [bifenthrin](#), [resmethrin](#), [deltamethrin](#), and [d-phenothrin](#).



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What happens to piperonyl butoxide (PBO) when it enters the body?

Once it enters the body, PBO is partly broken down and is removed from the body quickly. In one study, rats were given small or medium doses of PBO. Between 87% and 99% of the PBO left the body in urine and feces within 48 hours. When PBO was applied to the arms of human volunteers, about 2% of the applied dose was absorbed in 30 minutes.

PBO was applied on the skin of one goat and was fed to two others for five days. A very small amount of the original dose was found in the milk of all goats tested. Most of the dose that was fed to goats left the body within one day.

Laying hens were either fed PBO or had it applied to the skin for five days. Each day, increasing amounts of PBO were found in their eggs. The majority of the PBO left the body. However, PBO was found in the meat, fat, skin, and certain organs. The highest amounts of PBO were found in fat.

In human studies, the breakdown of one drug was not affected when volunteers ate a small dose of PBO.

Is piperonyl butoxide (PBO) likely to contribute to the development of [cancer](#)?

Laboratory studies have mixed results. Rats fed very high doses of PBO in their diet for almost two years had an increase in liver cancers. Mice fed high doses of PBO for one year also had an increase in liver tumors. Two other studies detected cancer-related effects in the intestines and thyroid glands in laboratory animals. However, increases in cancer were not detected in studies with rats and mice performed by the National Toxicology Program.

Based on these studies, the U.S. EPA has classified PBO as a possible human carcinogen. However, the Internal Agency for Research on Cancer (IARC) evaluated PBO and reported that it is "not classifiable as to its carcinogenicity to humans."

Has anyone studied non-cancer effects from long-term exposure to piperonyl butoxide (PBO)?

Yes. In one study, dogs were fed moderate to high doses of PBO every day for a year. At only the highest dose tested, animals had reduced weight gain and increased liver weights. In another study, rats were fed high to very high amounts of PBO for two years. Some animals had increased liver weights and other organ changes at the middle and highest doses. A mother goat and her breastfed young were fed a high dose of PBO almost every day for one year. No adverse outward effects were observed but certain changes to cells occurred in the adult goat's liver. No adverse health effects were seen in monkeys when given a moderate dose of PBO by mouth six days a week for four weeks.

In one study, pregnant rats were fed a single high to very high dose of PBO for two days. At the highest dose, pregnant rats gained less weight and lost more pregnancies than normal. At the highest two doses, some offspring weighed less than normal or had an unusual number of fingers and toes that were sometimes fused. In another study, rats were fed low to high doses of PBO for two generations to see if there were reproductive effects. Both adults and offspring had reduced weights at only the highest dose.

The EPA has evaluated PBO for its potential as an endocrine disruptor. Based on this evaluation, there was no convincing evidence of interaction with the estrogen, androgen, or thyroid pathways in mammals.

Are children more sensitive to piperonyl butoxide (PBO) than adults?

[Children may be especially sensitive to pesticides](#) compared to adults. The EPA has determined children are not more sensitive to PBO than adults. However, young children may act in ways that put them at greater risk of being exposed. For example, they may spend more time near the floor. They may also be more likely to place their hands in their mouths after touching treated surfaces or pets.



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What happens to piperonyl butoxide (PBO) in the environment?

PBO is quickly broken down in the presence of sunlight, with a [half-life](#) of 8.4 hours in water and 3.4 hours in air. In soil, sunlight and microbes can break down PBO. In shallow soil exposed to sunlight, half-lives ranged from 1-3 days. Without sunlight, the half-life increased to 14 days. Although the half-life in soil can be affected by many factors, a typical half-life for PBO is around 13 days.

PBO does not dissolve easily in water and may be more or less mobile depending on soil type. PBO can cling to soil types with more organic material. In one study, it had low to moderate mobility in sandy loam, clay loam, and silt loam soils, but was highly mobile in sandy soil. In another study, PBO did not leach through loam soils but did leach easily in sandy soils.

When applied to foliage, very little PBO moves to other parts of plant. Up to 5% of the applied dose was found in other plant tissues after it was applied to leaves of potato and cotton. When applied to growing lettuce, about three-quarters of the PBO on leaves broke down within 10 days.

Can piperonyl butoxide (PBO) affect birds, fish, or other [wildlife](#)?

PBO is practically non-toxic to birds and mammals. However, it is moderately toxic to freshwater and saltwater fish. PBO is moderately to highly toxic to aquatic invertebrates, such as water fleas and shrimp. At lower, long-term doses, water flea reproduction was affected. PBO is highly toxic to amphibians in the tadpole stage.

PBO is also practically non-toxic to bees by itself. However, PBO is often combined with insecticides that are toxic to bees. These may include insecticides like pyrethroids or natural pyrethrins.



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Where can I get more information?

For more detailed information about piperonyl butoxide (PBO) please visit the list of [referenced resources](#) or call the National Pesticide Information Center, between 8:00 AM and 12:00 PM Pacific Time (11:00 AM to 3:00 PM Eastern Time), Monday - Friday, at 1-800-858-7378 or visit us on the web at npic.orst.edu. NPIC provides objective, science-based answers to questions about pesticides.

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