This fact sheet was created in 2000; some of the information may be out-of-date. NPIC is not planning to update this fact sheet. More pesticide fact sheets are available here. Please call NPIC with any questions you have about pesticides at 800-858-7378, Monday through Friday, 8:00 am to 12:00 pm PST.

NPIC Technical Fact Sheets are designed to provide information that is technical in nature for individuals with a scientific background or familiarity with the regulation of pesticides by the U.S. Environmental Protection Agency (U.S. EPA). This document is intended to be helpful to professionals and to the general public for making decisions about pesticides.

Carbaryl

(Technical Fact Sheet)

For less technical information, please refer to the General Fact Sheet.

The Pesticide Label: Labels provide directions for the proper use of a pesticide product. *Be sure to read the entire label before using any product.* Signal words, listed below, are found on the front of each product label and indicate the product's potential hazard.

CAUTION - low toxicity **WARNING - moderate toxicity** **DANGER - high toxicity**

What is carbaryl?

- Carbaryl is the common name for the chemical 1-naphthyl methylcarbamate (1).
- Carbaryl belongs to a class of pesticides known as carbamates (2).
- Technical grade carbaryl is an odorless, non-corrosive, white to gray crystalline solid (3).
- Carbaryl was first registered for use in the United States in 1959 (1). See the **Laboratory Testing** box.
- Currently, over 300 products containing carbaryl are actively registered with the EPA (4).

Laboratory Testing: Before pesticides are registered by the U.S. EPA, they must undergo laboratory testing for short-term (acute) and long-term (chronic) health effects. Laboratory animals are purposely fed high enough doses to cause toxic effects. These tests help scientists judge how these chemicals might affect humans, domestic animals, and wildlife in cases of overexposure. When pesticide products are used according to the label directions, toxic effects are not likely to occur because the amount of pesticide that people and pets may be exposed to is low compared to the doses fed to laboratory animals.

How is carbaryl used?

- Carbaryl is used to control a wide variety of pests, including moths, beetles, cockroaches, ants, ticks, and mosquitoes (2).
- Carbaryl products are used for many different applications, including fruit trees, nut trees, vegetables, rangeland, lawns, soils, ornamental plants, and around buildings (1, 2).
- Products containing carbaryl can be formulated as liquid concentrates, wettable powders, dusts, granules, or baits (1).

What are some products that contain carbaryl?

- Sevin™
- Adios™

- Carbamec™
- Slam™

What is the mechanism of action for carbaryl?

- Carbaryl disrupts the normal functioning of the insect nervous system and may cause toxicity by contact or ingestion (2).

- Carbaryl disrupts the nervous system by adding a carbamyl moiety to the active site of the acetylcholinesterase enzyme, which prevents it from interacting with acetylcholine (5).

- The chemical neurotransmitter acetylcholine is used to relay nervous system signals across the nerve synapse (6).

- Acetylcholinesterase is the enzyme responsible for breaking down acetylcholine once it is released into the synapse. When the enzyme is inhibited, surplus acetylcholine builds up, resulting in nervous system overstimulation (6).

- The carbamyl group is released from the active site by spontaneous hydrolysis, clearing the acetylcholinesterase enzyme and restoring nerve function (7).

What is the acute toxicity of carbaryl?

Oral

- Carbaryl is moderate in toxicity when ingested by male and female rats. The oral LD50 in male and female rats is 302.6 mg/kg and 311.5 mg/kg, respectively (1). See boxes on **Toxicity Category** and **LD50/LC50**.

- Carbaryl is low in toxicity to rabbits by ingestion. The acute oral LD50 in rabbits is 710 mg/kg (8).

Dermal

· Carbaryl applied to the skin of rats and rabbits is low in toxicity. The dermal LD50 is >2000 mg/kg for both species (1, 2).

· Carbaryl is not a skin or eye irritant for rabbits (2).

· Carbaryl is not a skin sensitizer for rabbits (1).

	High Toxicity (*Danger*)	Moderate Toxicity (*Warning*)	Low Toxicity (*Caution*)	Very Low Toxicity (*Caution*)
Oral LD50	Less than 50 mg/kg	50 - 500 mg/kg	500 - 5000 mg/kg	Greater than 5000 mg/kg
Dermal LD50	Less than 200 mg/kg	200 - 2000 mg/kg	2000 - 5000 mg/kg	Greater than 5000 mg/kg
Inhalation LC50 - 4hr	Less than 0.05 mg/l	0.05 - 0.5 mg/l	0.5 - 2 mg/l	Greater than 2 mg/l
Eye Effects	Corrosive	Irritation persisting for 7 days	Irritation reversible within 7 days	Minimal effects, gone within 24 hrs
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

U.S. Environmental Protection Agency, Office of Pesticide Programs, Label Review Manual, Chapter 7: Precautionary Labeling
http://www.epa.gov/oppfod01/labeling/lrm/chap-07.htm

Inhalation

- Carbaryl is practically non-toxic to rats by inhalation, with the LC50 greater than 3.4 mg/L (1).

Signs of Toxicity - Animals

- Signs of carbaryl poisoning may include behavioral changes, excessive tearing and salivation, muscle tremors, twitching, vomiting, and diarrhea. Severe intoxications can result in paralysis and death (7). Synergism did not occur when rats were intubated with carbaryl, organophosphates, or other pesticides at the same time (8).

- Dogs fed carbaryl at 375 mg/kg began to show signs of poisoning after 15-30 minutes. Symptoms continued for over 7 hours. Dogs ingesting carbaryl survived doses up to 500 mg/kg. Cats were the most sensitive species tested, with an oral LD50 between 125 and 250 mg/kg (8).

LD50/LC50: A common measure of acute toxicity is the lethal dose (LD50) or lethal concentration (LC50) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. LD50 is generally expressed as the dose in milligrams (mg) of chemical per kilogram (kg) of body weight. LC50 is often expressed as mg of chemical per volume (e.g., liter (l)) of medium (i.e., air or water) the organism is exposed to. Chemicals are considered highly toxic when the LD50/LC50 is small and practically non-toxic when the value is large. However, the LD50/LC50 does not reflect any effects from long-term exposure (i.e., cancer, birth defects, or reproductive toxicity) that may occur at levels below those that cause death.

- Carbaryl fed to weanling pigs at 150 and 300 mg/kg caused animals to lie down, walk with rear legs forward, stand abnormally, and sit with extreme awkwardness, and eventually caused ataxia (9).

Signs of Toxicity - Humans

- Early symptoms of acute carbaryl exposure may include headache, malaise, muscle weakness, nausea, gastrointestinal cramps, sweating, and restlessness. See the **Exposure** box (5, 10).

- Signs of acute carbaryl intoxication may include pin-point pupils, tearing, excessive salivation, nasal discharge, vomiting, diarrhea, muscle twitching, slurred speech, and ataxia. Severe poisonings can result in convulsions, CNS depression, coma, and death (5, 10).

- Two researchers voluntarily ingested doses of 2.8 and 5.45 mg/kg of carbaryl and used atropine to counteract its effects on the nervous system. Each experienced gastrointestinal pain, profuse sweating, weakness and nausea, and one vomited. Both recovered completely after 4 hours (11).

Exposure: Effects of carbaryl on human health and the environment depend on how much carbaryl is present and the length and frequency of exposure. Effects also depend on the health of a person and/or certain environmental factors.

- People working with carbaryl dusts and concentrated wettable powders have experienced dermatitis (11).

- Unless analyzed immediately, blood cholinesterase tests may appear falsely normal due to the rapid and spontaneous regeneration of the acetylcholinesterase enzyme (10). One study found blood cholinesterase levels of carbaryl workers typically fell within the normal range even though urine analysis showed heavy exposure was occurring (12).

Is carbaryl a carcinogen?

Animals

- Male mice exposed to 14.73 mg/kg carbaryl every day for 104 weeks had an increased incidence of malignant vascular neoplasms. Carbaryl was carcinogenic to female mice only at 1248.93 mg/kg/day (13). See **Cancer** box.

- Researchers fed carbaryl to rats as 0.05% of their diet for 2 years. No increase in tumors occurred in either species (8). The 2 year no observable effect level (NOEL) for rats is 200 mg/kg (2).

Cancer: The U.S. EPA has strict guidelines that require testing of pesticides for their potential to cause cancer. These studies involve feeding laboratory animals large *daily* doses of the pesticide over most of the lifetime of the animal. Based on these tests, and any other available information, EPA gives the pesticide a rating for its potential to cause cancer in humans. For example, if a pesticide does not cause cancer in animal tests, then the EPA considers it unlikely the pesticide will cause cancer in humans. Testing for cancer is not done on human subjects.

Humans

- The International Agency for Research on Cancer has not classified carbaryl as to its carcinogenicity for humans due to inadequate animal studies (14).

- The EPA considers carbaryl "likely to be carcinogenic in humans" due to increased tumor production in mice (13).

Does carbaryl cause reproductive or teratogenic effects?

Animals

- Rats given 50 or 100 mg/kg carbaryl orally for 60 days had dose-related reductions in sperm motility and count, with an associated increase in abnormal sperm. These effects were more pronounced in young rats (15).

- In a two generation study with rats, there were no adverse reproductive effects at the highest doses tested. These levels ranged from 92.43 - 124.33 mg/kg in males and 110.78 - 135.54 mg/kg in females. Pup survival was decreased in both generations at levels down to 23.49 - 31.34 mg/kg for males and 26.91 - 36.32 mg/kg for females (13).

- One study found no birth defects when carbaryl was administered to hamsters and rabbits (3).

- Researchers administered up to 20 mg/kg carbaryl in gelatin capsules to rhesus monkeys during days 20-38 of gestation. They found no adverse reproductive effects (16).

Humans
- A study examining 47 carbaryl workers with at least one year of experience found no significant differences in testicular function when compared with 90 unexposed workers (17).

Could chronic exposure to carbaryl cause health effects?

Animals
- Dogs given up to 414 ppm carbaryl in their diet for 1 year exhibited no significant health effects when compared to control animals. However, carbaryl causes reversible fat deposition in the proximal tubules of the kidneys in exposed chickens, dogs, rats, and rhesus monkeys (8, 18).

- Rats fed carbaryl at 20 mg/kg/day for 50 days were subjected to neurological tests. The treated group initially completed maze tests faster, learned the route in less time, and made fewer mistakes than unexposed control rats due to overstimulation of the nervous system. However, the exposed animals' performance decreased to a point below that of the controls by the end of the study (19).

Humans
- Male volunteers ingested carbaryl at 0.06 and 0.12 mg/kg for 6 weeks and developed no signs or symptoms of intoxication, including neurologic effects. There was a temporary reduction in the ability to reabsorb amino acids at the highest dose (18).

What is the fate of carbaryl in the body?

Animals
- Mammals excrete carbaryl in the urine and feces, primarily as 1-naphthol and glucuronic acid conjugates (2).

- In a study with rats, metabolites from an oral carbaryl dose were completely excreted within 48 hours (8).

- Holstein cows dosed with radioactively labeled carbaryl excreted 95% in the urine within 74 hours (20).

- Carbaryl administered orally to a goat was present in the milk with a maximum level of 0.928 ppm after 8 hours, but was not detectable after 72 hours (21).

Humans
- The primary metabolites excreted in the urine of humans exposed to carbaryl are 1-naphthol and related conjugates (1).

- The presence of 1-naphthol in the urine can be used as a qualitative indicator of carbaryl exposure (12).

Half-life: the time required for half of the compound to degrade.

1 half-life=50% remaining
2 half-lives=25% remaining
3 half-lives=12% remaining
4 half-lives= 6% remaining
5 half-lives= 3% remaining

The amount of chemical remaining after a half-life will always depend on the amount of the chemical present initially.

What is the environmental fate of carbaryl?

Water
- In the environment, carbaryl breaks down primarily through hydrolysis and microbial degradation to 1-naphthol and carbon dioxide (22).

- Carbaryl degrades in distilled water with a half-life of 3.2 hours at pH 9 and 12.1 days at pH 7 (23). Carbaryl is stable in acidic water with a half-life of 1600 days at pH 5 (23). See **Half-life** box.

- Carbaryl is degraded by photolysis in water, with a half-life of 21 days (22).

- Scientists observed that carbaryl in river water (pH 7.3 - 8), exposed to natural and artificial light, degrades completely within 2 weeks (24).

- Carbaryl has low solubility in water and sorption to soil particles depends on the organic matter content of the soil (25, 26).

- Carbaryl is moderately mobile in soils and can be found in the groundwater and surface water due to its widespread use and persistence under acidic conditions (26).

Air
- Carbaryl dissolved in water has low potential to volatilize. The low vapor pressure for carbaryl suggests that evaporation from treated surfaces will be minimal (22).

Soil
- The half-life of carbaryl ranges from 4 days in aerobic soils to 72.2 days in anaerobic soils. Carbaryl degrades more rapidly in aerobic soils due to microbial action (2, 25, 26).

- Carbaryl degrades nearly twice as fast in flooded soils compared to dry soils due to hydrolysis and microbial action (25).

Plants
- Scientists observed 59.1% of carbaryl remaining 1 week after injection into bean plants and only 6.9% after 2 weeks (21).

- The mean foliar half-life of carbaryl on plants is 3.2 days (26).

- Carbaryl is slowly taken up by plants and breaks down through hydrolysis producing 1-naphthol, 4-hydroxycarbaryl, 5-hydroxycarbaryl, and methylol-carbaryl (1, 2).

Does carbaryl degrade indoors?

- Researchers applied a 5% carbaryl dust to dorm rooms. Airborne concentrations decreased to 15% of the peak concentration after 1 day, 7.5% of the peak concentration after 2 days, and less than 1% of the peak after 3 days (27).

- Indoor air concentrations of carbaryl were monitored after application to trees and shrubs outside 38 homes. Twenty two of the homes had no detectable levels during application to 7 hours afterwards. Sixteen other homes had a time-weighted average of 0.013 mg/m^3 during this same time frame. This level is 0.26% of the OSHA 40-hour work week standard for exposure (28).

Does carbaryl affect wildlife?

Birds
- Carbaryl is practically non-toxic to ringneck pheasants, California quail, mourning dove, and mallard ducks . The LD50 for acute exposure is >2000 mg/kg and the LC50 for subacute dietary exposure is >5000 mg/kg (26). The LD50 for acute exposure in pigeons ranges from 1000 to 3000 mg/kg (2).

- Birds exposed to carbaryl for an extended period of time may produce fewer eggs, have a higher number of cracked eggs, and are less fertile (26).

Fish and Aquatic Life
- The 96-hour LC50 for fish exposed to carbaryl ranges from 0.25 mg/L for the Atlantic salmon to 20 mg/L for the black bullhead, indicating carbaryl can be highly to slightly toxic to fish, depending upon the species (1, 26, 29).

- Carbaryl is very highly toxic to freshwater invertebrates. Carbaryl has a 48-hour LC50 of 6 µg/L in water fleas (*Daphnia magna*), 5.6 µg/L in glass shrimp, and 1.7 to 5.6 µg/L in stoneflies (1, 2, 26).

Terrestrial Invertebrates

- Carbaryl is highly toxic to honey bees, with a topical LD50 of 1 µg/bee (1, 2).

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