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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 (US EPA). This document is intended to be helpful to professionals and to the general public for making decisions about pesticides.

# Captan

## (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 captan?

- Captan is a chloroalkylthio fungicide that belongs to the dicarboximide chemical family (1, 2).
- Products containing captan carry **Signal Words** of Caution, Warning, and Danger, depending on formulation (3). See **The Pesticide Label**.

## How is captan used?

- Captan is used on a variety of terrestrial and greenhouse food/feed crops, post-harvest fruit dips, indoor non-food uses, seed treatment, and ornamental sites (1).
- Captan can be formulated as an emulsifiable concentrate, flowable concentrate, ready-to-use liquid, liquid soluble concentrate, solid, water dispersible granules, wettable powder, and dust (1).

**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.

## What are some products that contain captan?

- Orthocide
- Captan 300
- Captan 400
- Merpan
- Vondcaptan
- Many captan products simply have "Captan" in their name.

## What is the mechanism of action for captan?

- Captan is a non-specific thiol reactant with protective and curative action that works by inhibiting respiration of numerous species of fungi and bacteria (1, 4).
- The mechanism of action may involve the degradation of captan into the short-lived thiophosgene, which is a highly reactive with thiols and other functional groups (5).

## What is the acute toxicity of captan?

### Oral

- Technical grade captan is low in toxicity when ingested by both rats and mice with oral LD50 values of >9,000 mg/kg and >7,000 mg/kg, respectively (1,2). See boxes on **Laboratory Testing, LD50/LC50, and Toxicity Category**.
- A formulated captan product, captan 50W, has an oral LD50 of 8,400 mg/kg in mammals (5).
- Sheep and cattle are susceptible to captan poisoning. Sheep died after a single 250 mg/kg oral dose of captan (2).

### Dermal

- Dermally-applied captan is low in toxicity to rabbits, with an acute LD50 of >4,500 mg/kg (4).
- Captan causes mild to no irritation on the skin of rabbits (1, 4).
- Scientists applied 0.5 gram of technical grade captan to both abraded and intact skin of rabbits; after 24 to 48 hours no redness or edema in was observed (5).

- Researchers found captan causes moderate skin sensitization to the skin of guinea pigs (1).
- Technical grade captan causes irreversible corneal opacity to the unwashed eyes of rabbits after 21 days of exposure (1).

### Inhalation

- Inhaled captan is low in toxicity to rats, with LC50 values of 0.72 mg/L (female) and 0.87 mg/L (male) (1).

### Signs of Toxicity - Animals

- Signs of overexposure to captan include hypothermia, listlessness, depression, diarrhea, weight loss, anorexia, and increased water consumption (2, 6). See **Exposure** box.

### Signs of Toxicity - Humans

- Individuals working with captan or in fields where captan was applied reported eye and skin irritation, according to the California Pesticide Illness Surveillance Program. Other eye and skin irritants could not be ruled out as the causative agent(s) (1).

**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.

Toxicity Category

	High Toxicity ( <i>Danger</i> )	Moderate Toxicity ( <i>Warning</i> )	Low Toxicity ( <i>Caution</i> )	Very Low Toxicity ( <i>Caution</i> )
<b>Oral LD50</b>	Less than 50 mg/kg	50 - 500 mg/kg	500 - 5000 mg/kg	Greater than 5000 mg/kg
<b>Dermal LD50</b>	Less than 200 mg/kg	200 - 2000 mg/kg	2000 - 5000 mg/kg	Greater than 5000 mg/kg
<b>Inhalation LC50 - 4hr</b>	Less than 0.05 mg/l	0.05 - 0.5 mg/l	0.5 - 2 mg/l	Greater than 2 mg/l
<b>Eye Effects</b>	Corrosive	Irritation persisting for 7 days	Irritation reversible within 7 days	Minimal effects, gone within 24 hrs
<b>Skin Effects</b>	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>

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

- Investigators conducted patch tests with 0.1 to 1.0% captan which they placed on the upper backs of 279 to 442 individuals who were currently, one time, or never employed in agriculture. The exposures resulted in a dose-dependent increase in the incidence of both allergic and irritant reactions. Out of the 442 people tested, 13 individuals at the highest dose experienced irritant reactions and 17 experienced allergic reactions. At the lowest dose two individuals experienced allergic reactions out of 279 tested (7).

## Are the metabolites of captan toxic?

- Tetrahydrophthalimide, or THPI, is the major metabolite of captan . THPI has an oral LD50 of 2,000 mg/kg in mammals (5).

## Is captan a carcinogen?

### Animals

- Charles River CD rats were fed 25 to 250 mg/kg/day captan for 2 years. Males exhibited hepatocellular hypertrophy and significant trends of adenomas and carcinomas in the kidney at 100 mg/kg/day. Both sexes showed an increased relative kidney weight and a decreased body weight. Males exhibited an increased relative organ weight for heart, brain, liver, and thyroid/parathyroid. The lowest observable effects level (LOEL) was determined to be 100 mg/kg/day (1). See box on **Cancer**.
- Wistar rats fed captan at doses of 6.25 to 98 mg/kg/day for 30 months develop uterine sarcomas in the highest dosage group (1).
- The B6C3F1 strain of captan were fed to mice at 900 and 2,400 mg/kg/day for 80 weeks. At the highest doses both male and female mice had increased occurrences of combined duodenal adenoma/polyps or adenocarcinomas (1).
- A positive dose-related appearance of duodenal tumors was observed in both sexes of ICR derived CD-1 Charles River mice. Furthermore, the appearance of gastric and duodenal hyperplasia and jejunal hyperplasia in females was also noted (1).
- When Charles River CD-1 mice were fed 15 to 900 mg/kg/day captan for 22 months they showed an increase in both benign and malignant small intestinal tumors at the highest dose level (1).

**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 U.S. EPA has assigned captan a carcinogenicity classification of B2, a probable human carcinogen. (1). See the box on **Cancer**.

## Does captan cause reproductive or teratogenic effects?

### Animals

- Captan is structurally similar to the compound thalidomide, which is a known human teratogen. Researchers have used several animal models to study the potential for captan to be a teratogen including the rabbit, which has been shown to be quite sensitive to thalidomide (2).

- Captan is not teratogenic in rats, hamsters, and two strains of rabbits fed the doses: 2,000 mg/kg/day (rat), 1,000 mg/kg/day (hamster), and 75 mg/kg/day (rabbit) during pregnancy. Captan is not teratogenic in the dog, rhesus monkey or stump-tailed macaques at these doses: 1.38 mg/kg/day (dog), and 75 mg/kg/day (monkeys) during pregnancy (2).
- There is no significant embryo toxicity in New Zealand White rabbits administered captan by oral gavage at 80 mg/kg/day during day 7 to 12 of pregnancy (2). In a separate study, rabbits exposed from day 7 to 19 of pregnancy exhibited increased skeletal defects in fetuses at 30 mg/kg/day (oral gavage) and increased post-implantation loss, reduced fetal weight, and altered growth at 100 mg/kg/day (1). The developmental No Observable Adverse Effects Level (NOAEL) was set at 10 mg/kg/day (1).
- In a one-generation reproduction study, parents and pups of COBS CD rats fed up to 25 mg/kg/day showed no adverse effects (1). The pup toxicity NOAEL was determined to be 12.5 mg/kg/day (1).
- In a three-generation reproduction study, investigators fed 25 to 500 mg/kg/day captan to COBS CD rats. Pups showed a decrease in individual and litter weight at 25 mg/kg/day. Parents exhibited toxicity at 100 mg/kg/day, and they showed a decrease in body weight gain and food consumption. Offspring survival was reduced at 250 mg/kg/day and parental toxicity was first observed at 100 mg/kg/day. The offspring toxicity NOAEL was set at 12.5 mg/kg/day (1).

### **Humans**

- No data was found on the teratogenic or reproductive effects of captan.

## **Could chronic exposure to captan cause health effects?**

### **Animals**

- A heifer died after 6 oral doses at 250 mg/kg/day. Sheep were unaffected by 100 doses at 50 mg/kg/day and tolerated, with some signs of poisoning, 72 doses at 100 mg/kg/day or 38 doses at 200 mg/kg/day (2).
- Rats ingesting captan in their diets for 54 weeks at 10,000 mg/kg feed had impaired growth. Similar results were observed in female rats when they were fed 5,000 and 1,000 mg/kg in their food for 2 years. There were no significant changes in organ weights, blood chemistry, or gross and histological morphology in these studies (2).
- Dogs fed 300 mg/kg/day captan for 48 weeks had an increase in kidney and liver weights. This did not occur at 100 mg/kg/day. There were no significant changes in blood chemistry or gross/histological morphology at any treatment level (2). The No Observable Effect Level (NOEL) was set at 10 mg/kg/day for body weight gain and 60 mg/kg/day for food intake (5).
- Scientists observed suppression of both T and B-cell function in rats and mice 42 days after a dose of 3000 mg/kg. Depression of lymphocyte count and thymus weight was observed in rats fed 50 mg/kg/day for 3 weeks immediately following weaning. When challenged with tetanus toxoid, rats administered 37.5 and 100 mg/kg/day captan both pre- and postnatal exhibited a decrease in secondary IgG responses (5).

## **What is the fate of captan in the body?**

### **Animals**

- The majority of captan metabolism takes place in the gastrointestinal tract. This is based on differences in metabolite profiles from animals fed captan or injected intra-peritoneally (1,2).

- Within 24 hours following oral ingestion of 143 or 390 mg/kg <sup>35</sup>S-labeled captan, rats excreted 90% of the radioactivity in urine and feces. The animals excreted the remainder within 72 hours post-exposure, with less than 0.05% of the radioactivity incorporated into unspecified body tissues (2).
- Scientists tagged the trichloromethyl group of captan with <sup>14</sup>C and orally administered it to rats. The radioactivity was recovered as follows: 51.8% in the urine, 22.8% in expired air, 15.9% in feces, and 0.6% in body tissue (2).

### Humans

- Researchers utilized two captan metabolites found in the urine, THPI and 2-thiothiazolidine-4-carboxylic acid (TTCA), as biomarkers of human occupational exposure to captan (8, 9).
- Investigators measured THPI in the urine of human volunteers for 72 hours following ingestion of 1 mg/kg captan. The majority was excreted within the first 24 hours. The TTCA and THPI recovered from urine of humans made up <10% of the orally-delivered dose of captan (10).

## What is the environmental fate of captan?

### Soil

- The initial environmental degradation products of captan are THPI and thiophosgene. The latter was never detected as a volatile component in environmental fate studies submitted to EPA (1).
- The soil half-life values for captan range from < 1 to 10 days depending on soil conditions (1, 11). The soil half-life values for THPI range from 5.4 to 20 days (1). See the **half-life** box.
- Photodegradation rates for captan on soil are 5 to 15 days (1).
- Captan is slightly mobile to relatively immobile in various soils. In terrestrial dissipation studies, captan was not detected deeper than 12 inches from the soil surface (1). THPI is relatively immobile to slightly mobile and was not detected below 12 inches from the soil surface (1).

**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.

### Water

- Under aerobic aquatic conditions, the half-life of captan is less than 1 day. The calculated half-life of THPI is 7 days (1).
- In pesticide monitoring programs, captan was detectable in 4 out of a combined 1828 total samples taken as a part of regional ground water surveys. THPI or other breakdown products were not monitored and areas where captan was used were not a specific focus of the study (1).

### Air

- No data were found on the volatility of captan.

### Plants

- Foliar half-lives for captan range from 3 to 13 days (1).

## Does captan affect wildlife?

### Birds

- Captan is practically non-toxic to slightly toxic to Northern bobwhite quail and mallard on both acute and subacute dietary basis. The acute LD50s are >2000 mg/kg and the subacute dietary LC50s are >2400 ppm feed (1). Captan is non-toxic to starlings or red-winged blackbirds at 100 mg/kg body weight (4).
- Birds fed captan at amounts up to 1,000 mg/kg did not show adverse reproductive effects. This level would not be expected through appropriate application of products containing captan (1).

### **Fish and Aquatic Life**

- Captan is highly to very highly toxic to bluegill sunfish, fathead minnow, brook trout, coho salmon, harlequin fish and brown trout. The respective 96 hr. LC50s are 72 to 310 µg/L, 65 µg/L, 34 µg/L, 137 µg/L, 300 µg/L, and 26.2 to 34 µg/L (1, 4).
- THPI is practically non-toxic to rainbow trout with 96-hr LC50s >120,000 µg/L (1).
- A full life-cycle study indicated that fathead minnow growth and survival was affected at captan doses between 16.5 and 39.6 µg/L (1).
- Captan is moderately toxic to the freshwater invertebrate, *Daphnia magna*, with LC50s ranging from 3.25 to 10 mg/L (1, 4). THPI is practically non-toxic to *Daphnia magna* with a 48-hr LC50 >113 mg/L (1).
- Captan caused reproductive effects in *Daphnia magna* between 0.56 to 1.0 mg/L under static exposure conditions (1).
- Captan is moderately toxic to Dungeness crab (>1 ≤ 10 mg/L) (1).
- Several algae species exhibited a 50% growth inhibition at less than 1 mg/L of captan (1).

### **Terrestrial Invertebrates**

- Captan is relatively non-toxic to honey bees, with a contact LD50 of >10 µg/bee (1).

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