

Pesticide Toxicity Profile: Coumarin and Indandione Rodenticides ¹

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This document provides a general overview of human toxicity, provides a listing of laboratory animal and wildlife toxicities and a cross reference of chemical, common and trade names of coumarin and indandione rodenticides registered for use in Florida.

General

Rodenticides pose risk for accidental poisonings for several reasons. They are agents specifically designed to kill mammals; often their toxicity is very similar for the target rodents and for humans. Since rodents usually share environments with humans and other mammals, the risk of accidental exposure is an integral part of the placement of baits for the rodents. As rodents have developed resistance to existing rodenticides, there is a continuous need to develop new and potentially more toxic rodenticides. There are currently three active ingredients belonging to the coumarin rodenticide family registered for use in Florida: brodifacoum, bromadiolone, and warfarin. Brodifacoum was first registered in 1979. It is registered for controlling rats and mice in and around structures, households, industrial sites, and

transportation vehicles including trucks, ships, and airplanes. Brodifacoum products are available to the general public and applications may be made as often as necessary. Its mechanism of action is an anticoagulant and it is absorbed through the gut, inhibiting vitamin K-dependent steps in the synthesis of multiple clotting factors. Bromadiolone is very similar chemically to brodifacoum. Both of these compounds were designed to also control rodents which were resistant to warfarin, and both are formulated in a variety of pelleted, granular, block, and bait products. Warfarin was registered for use in 1952 and was the first anticoagulant to be used. Repeated ingestion of warfarin is necessary for it to produce its anticoagulation effects. It is also a general use pesticide available to the public. Products containing low concentrations and ready-to-use formulations carry the signal word, "CAUTION." Generally, mice are more difficult to control than rats with warfarin and may take longer. Some available products containing warfarin are formulated as solutions and are labeled for control of moles. There are two active ingredients of the indandione family of rodenticides: chlorophacinone and diphacinone.

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The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication does not signify our approval to the exclusion of other products of suitable composition. Use pesticides safely. Read and follow directions on the manufacturer's label.

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Indandiones are not only anticoagulants; they also uncouple oxidative phosphorylation (energy generation) in mammals. Chlorophacinone and diphacinone have both general and restricted use products on the market. The general use products tend to be formulated as low percentage ready-to-use and carry the signal word, "CAUTION," whereas some of the restricted products have "WARNING" on their labels. Chlorophacinone and diphacinone products that are restricted are classified as such because EPA considers them to possess high acute oral toxicity.

Toxicity

Warfarin and related anticoagulant compounds are the most commonly ingested rodenticides in the United States, with 13,345 exposures reported in 1996 alone, approximately 96% unintentional, but others with suicidal intent. These materials are readily absorbed into the gastrointestinal tract. Warfarin can be absorbed across the skin, but this has occurred only under extraordinary circumstances. It usually takes several days for warfarin ingestion before a rodent dies because of the long half-lives of the vitamin K-dependent clotting factors. Lethal hemorrhage may follow smaller doses of the modern, more toxic compounds, such as brodifacoum. These compounds have been called "superwarfarins" because their toxicities are much greater than warfarins (Table 1). Effects of these rodenticides on humans include bleeding symptoms, but also cause anemia, and fatigue. Severe cases progress into shock and death. Over the years, these compounds had clinical uses and are widely known for therapeutic anticoagulant effects, but warfarin has been established as a human teratogen, because it causes birth defects in the offspring of women receiving blood-thinning treatment with the compound during any trimester of pregnancy. No information is currently available on warfarin's reproductive, mutagenic, and carcinogenic effects. The use of diphacinone in humans as an anticoagulant drug has been apparently discontinued. Diphacinone was not shown to be mutagenic, but there are no data currently available on its reproductive, teratogenic, and carcinogenic effects. Studies with cattle indicate a high tolerance to diphacinone; it is used in Latin America for controlling vampire bats preying on

cattle. Ecologically, the main concern with the coumarins and indandiones is secondary poisoning. Mortality is a likely result in wildlife which feed on rodents that have ingested these compounds. Bromadiolone and brodifacoum are also toxic to fish, should sufficient amounts reach water sources. Mammalian toxicities for the coumarin and indandione rodenticides are shown in Tables 1 and 2, respectively. Tables 3 and 4 list the toxicities to wildlife, if known, by the common name of the pesticide. Tables 5 and 6 provide a cross listing of some of the trade names that these products are registered and sold by in Florida.

Additional Information

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Table 1. Coumarin rodenticide mammalian toxicities (mg/kg of body weight).

Common name	Rat oral LD ₅₀	Dermal LD ₅₀
Brodifacoum	0.27	---
Bromadiolone	0.56 – 0.84	---
Warfarin	3.0	800

Table 2. Indandione rodenticide mammalian toxicities (mg/kg of body weight).

Common name	Rat oral LD ₅₀	Dermal LD ₅₀
Chlorophacinone	3.15	---
Diphacinone	7.0	---

Table 3. Coumarin rodenticide wildlife toxicity ranges.

Common name	Bird acute oral LD ₅₀ (mg/kg)*	Fish (ppm)**	Bee [†]
Brodifacoum	VHT	VHT	---
Bromadiolone	ST – MT	HT	PNT
Warfarin	PNT	ST - PNT	PNT

*Bird LD₅₀: Practically nontoxic (PNT) = >2,000; slightly toxic (ST) = 501 – 2,000; moderately toxic (MT) = 51 – 500; highly toxic (HT) = 10 – 50; very highly toxic (VHT) = <10.

**Fish LC₅₀: PNT = >100; ST = 10 – 100; MT = 1 – 10; HT = 0.1 – 1; VHT = <0.1.

[†]Bee: HT = highly toxic (kills upon contact as well as residues); MT = moderately toxic (kills if applied over bees); PNT = relatively nontoxic (relatively few precautions necessary).

Table 4. Indandione rodenticide wildlife toxicity ranges.

Common name	Bird acute oral LD ₅₀ (mg/kg)*	Fish (ppm)**	Bee [†]
Chlorophacinone	---	---	PNT
Diphacinone	ST – PNT	MT	---

*Bird LD₅₀: Practically nontoxic (PNT) = >2,000; slightly toxic (ST) = 501 – 2,000; moderately toxic (MT) = 51 – 500; highly toxic (HT) = 10 – 50; very highly toxic (VHT) = <10.

**Fish LC₅₀: PNT = >100; ST = 10 – 100; MT = 1 – 10; HT = 0.1 – 1; VHT = <0.1.

[†]Bee: HT = highly toxic (kills upon contact as well as residues); MT = moderately toxic (kills if applied over bees); PNT = relatively nontoxic (relatively few precautions necessary).

Table 5. Cross reference list of common, trade and chemical names of coumarin rodenticides.

Common name	Trade names*	Chemical name
Brodifacoum	D-Con®, Enforcer®, Havoc®, Jaguar®, Talon®, others	3-[3-(4-bromo[1-1-biphenyl]-4-yl)-1,2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one
Bromadiolone	Conrac®, Hawk®, Maki®, Tomcat®, V Rat®, others	3-[3-(4-bromo[1-1-biphenyl]-4-yl)-3-hydroxy-1-phenylpropyl]-4-hydroxy-2H-1-benzopyran-2-one
Warfarin	Bonide®, Kaput®, Rodex®, others	3-(a-acetonylbenzyl)-4-hydroxycoumarin
*Does not include manufacturer's prepackaged mixtures.		

Table 6. Cross reference list of common, trade and chemical names of indandione rodenticides.

Common name	Trade names*	Chemical name
Chlorophacinone	Enforcer®, Rozol®, others	2-[(4-chlorophenyl)phenylacetyl]-1H-indene-1,3(2H)-dione
Diphacinone	Ditrac®, Ramik®, others	2-(diphenylacetyl)-1,3-indandione
*Does not include manufacturer's prepackaged mixtures.		