

Dicamba

Guideline

The maximum acceptable concentration (MAC) for dicamba in drinking water is 0.12 mg/L (120 µg/L).

Identity, Use and Sources in the Environment

Dicamba is a broad-spectrum chlorobenzoic acid herbicide used in large quantities for general weed control on grain crops, pastures and non-crop areas. Between 500 000 and 1 million kilograms of dicamba, its amine salt or its butoxyethyl ester are sold annually in Canada.¹

Dicamba is only slightly soluble in water, but its salts and esters are freely soluble.² Its vapour pressure at 20°C is 3.9×10^{-6} Pa. It is stable to oxidation and hydrolysis, and it is persistent in soil, remaining three to 12 months.³ Dicamba is not strongly adsorbed onto soil particles and is readily leached to groundwater;⁴ it has therefore been considered a Priority A chemical with respect to potential for groundwater contamination by the U.S. Environmental Protection Agency.⁵

Exposure

Dicamba was not found in municipal water supplies in Alberta, but it was detected on two occasions (out of 48 analyses) in municipal water supplies in Manitoba and in about 6% of private wells monitored in southern Ontario,⁶⁻⁸ with a maximum recorded concentration of 2.3 µg/L.⁸ Dicamba has occasionally been detected in trace amounts in surface waters of Manitoba and Ontario.⁸ It was present in 18% of surface water samples in the Thames River basin, Ontario.⁹

Based on the residue tolerance limits set by the Food Directorate of the Department of National Health and Welfare¹⁰ and on average Canadian consumption patterns,¹¹ the theoretical maximum dietary intake of dicamba for an adult Canadian would be 0.0003 mg/kg bw per day, or less than 3% of the acceptable daily intake (ADI) established by the Department of National Health and Welfare, assuming that every crop for which it is registered for use contained it at the maximum tolerable level of 0.1 µg/g. Actual intake will be less

than this “worst-case” assumption. The theoretical maximum dietary intake in the United States is about 10 times this value, 33% of the ADI, because of higher residue tolerances and a greater number of registered crop uses.¹² Dicamba was not included in total diet residue surveys in either Canada or the United States.

Analytical Methods and Treatment Technology

Dicamba may be monitored in water using isotope dilution, gas chromatographic/mass spectrometric extraction,¹³ methylation and gas chromatography¹⁴ or pentafluorobenzoylation and gas chromatography with electron capture detection.¹⁵ The detection limit in the last technique was 0.05 to 0.1 µg/L,^{9,15} and the quantitation limit is therefore about 0.5 µg/L.

Granular activated carbon adsorption is reported to be a possible technique for removal of dicamba from drinking water.¹⁶

Health Effects

Dicamba is readily and almost completely absorbed by the gastrointestinal tract. Metabolism in rats is rapid, with 70% of the dose excreted unchanged in the urine in five hours, and most of the remainder within three days.¹⁷

Dicamba has a fairly low acute toxicity.⁴ Its principal toxic action is on the liver, with vacuolization, necrosis, fatty deposits and liver weight changes noted at high doses in rats and dogs.⁴ In a subchronic (15-week) study, male Wistar rats were administered technical dicamba in the diet at doses equivalent to 0, 3.8, 12, 37, 119 or 364 mg/kg bw per day. A no-observed-adverse-effect level (NOAEL) of 37 mg/kg bw per day was observed, based on increases in relative liver/body weight ratios at doses of 119 and 364 mg/kg bw per day.¹⁸

In a 13-week study, male and female Sprague-Dawley rats were administered technical dicamba, in a formulation with dimethylamine, in the diet at doses equivalent to 41, 206, 330 and 413 mg dicamba per kilogram diet per day. At the highest dose, 413 mg/kg in

the diet or about 21 mg/kg bw per day, necrosis and vacuolization of the liver were seen. The NOAEL for effects on the liver was 206 mg dicamba per kilogram diet or approximately 10 mg/kg bw per day (unpublished study, cited in reference 4).

Sprague-Dawley rats (32 per sex per dose) were administered technical dicamba in the diet at doses equivalent to 0, 0.25, 2.5, 5, 12.5 or 25 mg/kg bw per day for two years. No differences in survival, body weight, food consumption, organ weights or histology were noted at any dose, but the data presented were insufficient to allow estimation of a NOAEL.¹⁹

In a two-year study in which dogs (three per sex per dose) were administered technical dicamba in the diet at doses equivalent to 0, 0.125, 0.625 or 1.25 mg/kg bw per day, a decrease in body weight was observed in males at 0.625 and 1.25 mg/kg bw per day, with a NOAEL at 0.125 mg/kg bw per day. There were no compound-related effects on survival, food consumption, haematology, urinalysis or organ weights. No data were presented on gross pathology or histology of organs other than heart, lung, liver and kidney.¹⁹

No compound-related increases in tumour incidence were observed in the two-year dog study or the two-year rat feeding study,¹⁹ although it should be pointed out that these studies were inadequate to allow evaluation of the potential of dicamba as a carcinogen.

Dicamba was not mutagenic in several microbial test systems, including the Ames/*Salmonella* test.^{4,20,21} Further short-term tests are required for mammalian test systems, chromosome aberrations and DNA repair studies.

In a three-generation rat study in which CD rats (20 females and 10 males per dose) were fed dicamba at doses equivalent to 0, 0.25, 2.5, 5, 12.5 or 25 mg/kg bw per day, there were no effects on fertility, viability or pup development.²² No teratogenic or foetotoxic effects were noted in albino rats administered technical dicamba by gavage on days 6 to 19, at doses up to 400 mg/kg bw per day, the highest dose tested.¹⁶ New Zealand white rabbits were administered technical dicamba per os at doses of 0, 0.5, 1, 3, 10 or 20 mg/kg bw on days 6 to 18 of pregnancy. A NOAEL of 3 mg/kg bw per day was observed, based on reductions in both foetal and maternal body weights and increased post-implantation losses at 10 or 20 mg/kg bw per day. There were no teratogenic effects.²³

Rationale

Based on evaluations of unpublished data by the Food Directorate of the Department of National Health and Welfare,²⁴ an ADI for dicamba was established as follows:

$$ADI = \frac{1.25 \text{ mg/kg bw per day}}{100} = 0.0125 \text{ mg/kg bw per day}$$

where:

- 1.25 mg/kg bw per day is the NOAEL in a two-year feeding study in dogs⁴
- 100 is the uncertainty factor (×10 for intraspecies variation; ×10 for interspecies variation).

The maximum acceptable concentration (MAC) for dicamba in drinking water is derived from the ADI as follows:

$$MAC = \frac{0.0125 \text{ mg/kg bw per day} \times 70 \text{ kg} \times 0.20}{1.5 \text{ L/d}} \approx 0.12 \text{ mg/L}$$

where:

- 0.0125 mg/kg bw per day is the ADI, as derived above
- 70 kg is the average body weight of an adult
- 0.20 is the proportion of total daily intake of dicamba allocated to drinking water (theoretical maximum food intake is less than 3% of the ADI)
- 1.5 L/d is the average daily consumption of drinking water for an adult.

Note that application of a 1000-fold uncertainty factor in the derivation of the ADI gives an MAC of 0.01 mg/L.

References

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