

Bromoxynil

Guideline

The interim maximum acceptable concentration (IMAC) for bromoxynil in drinking water is 0.005 mg/L (5 µg/L).

Identity, Use and Sources in the Environment

Bromoxynil and its octanoate ester are phenolic benzonitrile-based herbicides employed for the control of broad-leaved weeds in grain crops. Over 1 million kilograms are used annually in Canada, principally in the Prairie provinces.¹

The solubility of bromoxynil in water is high, 130 mg/L at 25°C, and its vapour pressure is low, 1.0×10^{-3} Pa at 20°C.² Bromoxynil is relatively stable, persisting in soils for three to 12 months.³ Its octanoate ester is almost insoluble in water but is readily hydrolysed under alkaline conditions to the soluble parent form.⁴ The octanoate ester is chemically and microbially degraded to the parent phenol, with a short half-life of 10 to 14 days in soil.⁴ Bromoxynil was ranked high with respect to potential for groundwater contamination in an Agriculture Canada survey.⁵

Exposure

Traces (0.01 µg/L) of bromoxynil were detected in two of 48 municipal water samples in Manitoba (detection limit 0.01 µg/L) and in one of 149 private wells in Ontario (no concentration was given) (detection limit 0.1 µg/L).⁶

Based on the residue tolerance limits set by the Food Directorate of the Department of National Health and Welfare⁷ and on average Canadian consumption patterns,⁸ the theoretical maximum dietary intake of bromoxynil for an adult Canadian would be 0.0056 mg/d (0.00008 mg/kg bw per day). This intake is greater than actual intake, as it assumes that every crop with a negligible residue level contains the maximum level of 0.1 µg/g. No actual residue levels in foods are available, as bromoxynil was not included in total diet surveys in either Canada or the United States.

Analytical Methods and Treatment Technology

Bromoxynil octanoate may be analysed using solvent extraction and gas/liquid chromatography followed by electrolyte conductivity detection in the halogen mode. The detection limit is about 0.1 µg/L, and the quantitation limit is about 0.5 µg/L.⁹

No information has been found on the effectiveness of current treatment technologies in removing bromoxynil from drinking water.

Health Effects

Bromoxynil esters are metabolized rapidly in animals to the phenol bromoxynil,⁴ which is considered to be the active species (unpublished data, Food Directorate). Bromoxynil has a moderately high acute toxicity and acts by uncoupling oxidative phosphorylation.¹⁰ Its principal toxic action is on the liver. Higher doses may also affect the kidneys, thyroid and thymus. Signs of poisoning in human (occupational) exposure include sweating, thirst, headache, dizziness, vomiting, weight loss and elevations in liver enzyme levels.¹⁰

Bromoxynil has been considered to be non-tumorigenic, with negative results in two acceptable long-term studies on the mouse and rat.¹¹ A no-observed-adverse-effect level (NOAEL) of 10 ppm (approximately 0.5 mg/kg bw per day) was determined in an 18-month mouse gavage study in which higher doses resulted in hyperplastic hepatic nodules, not statistically significant even at the highest dose of 5 mg/kg bw per day. Increases in liver and kidney weights, thyroid enlargement and swollen thymus were noted at higher doses. A NOAEL of 10 ppm (approximately 0.5 mg/kg bw per day) was noted in a 120-week rat study, where the principal effects were reduced liver/body weight ratios at 30 and 100 ppm (approximately 1.5 and 5 mg/kg bw per day).

Bromoxynil was negative in the Ames assay for mutagenicity with five strains of *Salmonella*. No other short-term test results are available. There were no treatment-related effects up to 300 ppm or 15 mg/kg bw

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per day in a three-generation rat reproduction study done in 1978, but histopathological data were insufficient. A rat teratology study was considered to be negative. Body weights and foetal development were normal, except for an increase in rib abnormalities that was also present in historical controls and therefore considered to be unrelated to treatment.¹¹

Rationale

Insufficient data are available on long-term toxicity of bromoxynil or its esters to non-rodents to establish an acceptable daily intake (ADI). Based on evaluations of unpublished data by the Food Directorate of the Department of National Health and Welfare, a negligible daily intake (NDI) for bromoxynil was established as follows:¹²

$$\text{NDI} = \frac{0.5 \text{ mg/kg bw per day}}{1000} = 0.0005 \text{ mg/kg bw per day}$$

where:

- 0.5 mg/kg bw per day is the NOAEL in an unpublished two-year rat feeding/oncogenicity study¹⁰
- 1000 is the uncertainty factor.

An interim maximum acceptable concentration (IMAC) for bromoxynil in drinking water was derived from the NDI as follows:

$$\text{IMAC} = \frac{0.0005 \text{ mg/kg per day} \times 70 \text{ kg} \times 0.20}{1.5 \text{ L/d}} \approx 0.005 \text{ mg/L}$$

where:

- 0.0005 mg/kg per day is the NDI, as derived above
- 70 kg is the average body weight of an adult
- 0.20 is the proportion of total daily intake of bromoxynil allocated to drinking water (theoretical maximum food intake is 16% of the NDI)
- 1.5 L/d is the average daily consumption of drinking water for an adult.

References

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