Haloaldehydes

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Background

Over the years a series of halogenated aldehydes have been identified as chlorination by-products. These potential toxicological effects of these compounds have attracted little attention.

Occurrence

Dichloroacetaldehyde and bromochloroacetaldehyde have been found in chlorinated drinking water at concentrations as high as 11 and 1.3 µg/L, respectively (see DBP-1). However, these DBPs are not measured in routine monitoring of DBPs. As a consequence, we were unable to locate data to their concentrations that might be expected in the product waters of potable reuse projects. Nevertheless, it is highly probable that they would occur. The molecular weight of dichloroacetaldehyde suggests that it would be likely to penetrate reverse osmosis membranes used in many potable reuse projects. The stability of this compound to biological degradation in the environment does not appear to have been studied.

Trihaloacetaldehydes are also known to be chlorination by-products. However, chloral hydrate has been extensively studied, is a very weak carcinogen only in mice. IRIS reviews of chloral hydrate indicate an RfD much higher than the concentrations that is seen to occur.

Other aldehydes, such as 2-chloropropenal, are known to be formed in the chlorination of drinking water (Meier, 1988). 2-chloropropenal is highly mutagenic, but there has been no systematic survey of the concentrations that occur in chlorinated drinking waters.

TTC analysis

Dichloroacetaldyde is mutagenic in the Salmonella/microsome assay and occurs at concentrations above 0.75 µg/L. No tests of bromochloroacetaldehyde appear to have been performed, but it is probable that it is also mutagenic. Therefore, assessment of the risks for these compounds requires chemical-specific evaluation of data.

Dichloroacetaldehyde is an established metabolite of vinylidene choride (Liebler et al., 1985; Dowsley et al., 1995), but its role in the carcinogenic effects of this chemical are overshadowed by the apparent reactivity of other metabolites.

We were unable to identify data that would establish whether the dihaloacetaldehydes are carcinogenic or not. No entry has been made in the Carcinogenic Potency Database, consistent with our inability to locate appropriate data.

There appear to be no conventional toxicology studies of the dihaloacetaldehydes.

Bull et al. (2006) subjected a number of DBPs to QSAR study as carcinogens and/or developmental toxicants. Dichloroacetaldehyde met the criteria as a probable carcinogen. A chronic LOAEL of 5.8 mg/kg was also predicted. This LOAEL is approximately 1/10 that observed with commonly regulated haloacetic acid and THM DBPs. The QSAR program did not identify dichloroacetaldehyde as a probable developmental toxicant.

Research Recommendation

The occurrence of dihaloacetaldehydes has not been surveyed in potable reuse projects. As a consequence, it is not known whether these DBPs are produced in greater or lesser amounts than in drinking water systems drawing their water from surface sources. Given the concentrations that are found in the more conventionally derived drinking waters and the mutagenic activity of the compound, we must identify it as a DBP deserving some research. It will be difficult to make a case for this compound without a more extensive database on its occurrence in potable reuse projects.

Based upon its relationship with several other known carcinogenic compounds, either as a metabolite or as a product (dichloroacetaldehyde should be easily oxidized to dichloroacetic acid), the only nomination that makes sense at this time would be a lifetime bioassay of its carcinogenic properties in rodents by the National Toxicology Program.

References

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