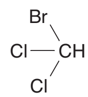
Bromodichloromethane

CAS No. 75-27-4

Reasonably anticipated to be a human carcinogen

First listed in the *Sixth Annual Report on Carcinogens* (1991)



Carcinogenicity

Bromodichloromethane is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals

Oral exposure to bromodichloromethane caused tumors at several different tissue sites in mice and rats. Administration of bromodichloromethane by stomach tube caused benign and malignant kidney tumors (tubular-cell adenoma and adenocarcinoma) in male mice and in rats of both sexes, benign and malignant liver tumors (hepatocellular adenoma and carcinoma) in female mice, and benign and malignant colon tumors (adenomatous polyps and adenocarcinoma) in rats of both sexes (NTP 1987, ATSDR 1989, IARC 1991, 1999).

Since bromodichloromethane was listed in the *Sixth Annual Report on Carcinogens,* additional studies in rats have been identified. Administration of bromodichloromethane in the drinking water increased the combined incidence of benign and malignant liver tumors (hepatocellular adenoma or carcinoma) in males (George *et al.* 2002) and caused benign liver tumors (hepatocellular adenoma) in females (Tumasonis *et al.* 1987).

Cancer Studies in Humans

The data available from epidemiological studies are inadequate to evaluate the relationship between human cancer and exposure specifically to bromodichloromethane. Several epidemiological studies indicated a possible association between ingestion of chlorinated drinking water (which typically contains bromodichloromethane) and increased risk of cancer in humans, but these studies could not provide information on whether any observed effects were due to bromodichloromethane or to one or more of the hundreds of other by-products also present in chlorinated water (ATSDR 1989).

Properties

Bromodichloromethane is a trihalomethane that exists as a colorless liquid at room temperature. It is slightly soluble in water and very soluble in ethanol, ethyl ether, benzene, and acetone. It is stable at normal temperatures and pressures (Akron 2009, HSDB 2009). Physical and chemical properties for bromodichloromethane are listed in the following table.

Property	Information
Molecular weight	163.8
Specific gravity	1.980 at 20°C/4°C
Melting point	–57°C
Boiling point	90°C
Log K_{ow}	2.00
Water solubility	3.96 g/L at 30°C
Vapor pressure	50 mm Hg at 20°C

Source: HSDB 2009.

Use

Bromodichloromethane is used in the synthesis of organic chemicals and as a reagent in laboratory research. It previously was used as a solvent for fats, waxes, and resins, and it has been used to separate minerals and salts, as a flame retardant, and as an a ingredient in fire extinguishers (ATSDR 1989).

Production

Bromodichloromethane is not used or produced commercially in the United States. Small quantities have been produced, but production volumes were not found (ATSDR 1989). In 2009, bromodichloromethane was available from 18 suppliers worldwide, including 11 U.S. suppliers (ChemSources 2009). No data on U.S. imports or exports were found, but little, if any, trade is expected (ATSDR 1989).

Exposure

Bromodichloromethane is a by-product of water disinfection, and the main route of human exposure is through exposure to chlorine-treated water (IARC 1991). The amount of bromodichloromethane produced during chlorination depends on temperature, pH, the bromide ion concentration of the water, the presence of trihalomethane precursors, and the specific treatment processes (ATSDR 1989). The organic trihalomethane precursors are naturally occurring humic and fulvic acids. The general population is exposed to trihalomethanes through consumption of treated drinking water, beverages, and food products, inhalation of contaminated air, and dermal contact with treated water.

As water-disinfection by-products, trihalomethanes occur at higher concentrations in finished water than in raw waters. It is estimated that bromodichloromethane levels increase by 30% to 100% in water distribution pipes; formation of bromodichloromethane is likely to continue as long as chlorine and organic trihalomethane precursors remain in the water (ATSDR 1989). Since 1998, the concentration of total trihalomethanes in public water systems has been limited to 80 ppb (μg/L) (EPA 1998). The highest detected concentration of bromodichloromethane before regulations went into effect was in New Orleans, Louisiana, where its concentration was 11 ppb (μg/L) in raw water and 116 ppb in finished water (NRC 1980). In the water supplies of 113 U.S. cities surveyed from 1976 to 1977, the mean bromodichloromethane concentration was 18 ppb (IARC 1991). Bromodichloromethane was detected in 445 of 945 finished water supplies from groundwater sources in a survey conducted from 1981 to 1982, at a median concentration of approximately 1.8 ppb (HSDB 2009), and in 35 of 40 Michigan water supplies at a median concentration of 2.7 ppb (Furlong and D'Itri 1986). Bromodichloromethane was found in 14 of 63 industrial wastewater discharges, at concentrations ranging from less than 10 to 100 ppb (HSDB 2009).

The tap-water uses associated with the greatest bromodichloromethane exposure, based on concentrations of total trihalomethanes in the blood or exhaled breath, were showering, bathing, and hand dishwashing (Ashley *et al.* 2005, Nuckols *et al.* 2005). Ingestion of tap water or hot or cold beverages containing tap water did not increase blood or exhaled breath concentrations. The concentration of bromodichloromethane in the blood increased 3- to 4-fold after showering; for two study sites, the median blood concentrations were 38 and 43 ppt (ng/L) after showering (Nuckols *et al.* 2005), and the median water concentrations of bromodichloromethane were 14 and 12 ppb.

Exposure can also occur from dermal contact with and ingestion of chlorinated swimming-pool water. Individuals who frequent indoor swimming pools and saunas potentially are at higher risk from inhalation exposure (ATSDR 1989). Bromodichloromethane was detected at concentrations of 13 to 34 ppb in chlorinated freshwater pools (Beech *et al.* 1980). Another study examined dermal and inhalation exposure of two college students (one male and one female) to bromodichloromethane during a typical two-hour swimming workout. The results suggested that the main route of exposure was dermal, rather than inhalation, and showed that training was associated with a measurable body burden of bromodichloromethane (Lindstrom *et al.* 1997). Another study found that concentrations of bromodichloromethane in the urine of swimming-pool workers depended on its concentration in the air in the swimming-pool enclosure and increased over the course of a four-hour shift by a factor of 2.5 (Caro and Gallego 2007). At the same pool, concentrations of bromodichloromethane in the urine of swimmers increased by a factor of 3 to 4 after one hour of exercise. Because the workers and swimmers were exposed to the same air concentration of bromodichloromethane, the difference in uptake was attributed to dermal absorption by the swimmers. These results agree with those of a similar study of swimmers that measured bromodichloromethane in alveolar air before and after swimming (Aggazzotti *et al.* 1998).

Although consumers potentially are exposed to bromodichloromethane from contaminated food, resulting from use of chlorinated water to produce these foods, such exposure is not common, and concentrations of bromodichloromethane in food are at or below concentrations in drinking water (HSDB 2009). In the U.S. Food and Drug Administration's Total Diet Study, bromodichloromethane was found in 46 food products, at concentrations ranging from 3 ppb (the limit of quantitation) to 37 ppb (FDA 2003). Bromodichloromethane was detected in cola drinks at concentrations of 2.3 to 3.8 ppb in one study (HSDB 2009); in another study, it was found in non-caramel-colored soft drinks at 0.1 to 0.2 ppb and in cola drinks at 0.9 to 5.9 ppb (Abdel-Rahman 1982).

Bromodichloromethane is not produced on a large commercial scale (HSDB 2009). If contamination occurs from a spill on land, volatilization will occur, which is the predominant environmental removal process, or the compound will leach into groundwater, where significant biodegradation can occur under anaerobic conditions. Bromodichloromethane has a relatively long half-life in air, estimated at 2 to 3 months (ATSDR 1989). Reactions with hydroxyl radicals or singlet oxygen are probably the only identifiable transformation processes in the atmosphere. Long-range global transport is possible. Bromodichloromethane has been detected in rainwater, indicating that washout from the atmosphere is possible; however, it is likely that the compound will revolatilize (HSDB 2009). According to the U.S. Environmental Protection Agency's Toxics Release Inventory, the largest total environmental releases of bromodichloromethane occurred in 1992, when 15,000 lb was released, all as fugitive air emissions. In 2007, one industrial facility released 296 lb of bromodichloromethane to the air (TRI 2009).

The potential for occupational exposure to bromodichloromethane is greatest among workers using it as a reagent for research or to synthesize organic chemicals. Most other uses have been discontinued (ATSDR 1989). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 3,266 workers, including 502 women, potentially were exposed to bromodichloromethane (NIOSH 1990).

Regulations

Environmental Protection Agency (EPA)

Clean Water Act

Effluent Guidelines: Halomethanes are listed as toxic pollutants.

Water Quality Criteria: Based on fish or shellfish and water consumption = 0.95 μg/L; based on fish or shellfish consumption only = 27 μg/L.

Comprehensive Environmental Response, Compensation, and Liability Act

Reportable quantity (RQ) = 5,000 lb.

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements.

Safe Drinking Water Act

Maximum contaminant level (MCL) = 0.080 mg/L for total trihalomethanes (sum of chloroform, bromodichloromethane, dibromochloromethane, and bromoform).

Food and Drug Administration (FDA, an HHS agency)

Maximum permissible level in bottled water = 0.08 mg/L for total trihalomethanes.

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