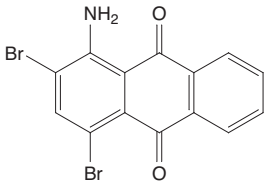
1-Amino-2,4-dibromoanthraquinone

CAS No. 81-49-2

Reasonably anticipated to be a human carcinogen

First listed in the *Eleventh Report on Carcinogens* (2004)

Also known as ADBAQ



Carcinogenicity

1-Amino-2,4-dibromoanthraquinone (ADBAQ) is *reasonably anticipated to be a human carcinogen* based on sufficient evidence from studies in experimental animals.

Cancer Studies in Experimental Animals

Oral exposure to ADBAQ caused tumors at several different tissue sites in rats and mice. ADBAQ administered in the diet caused benign and malignant liver tumors (hepatocellular adenoma and carcinoma) in rats and mice of both sexes. In rats of both sexes, it also caused cancer of the large intestine (carcinoma) and urinary bladder (transitional-cell carcinoma) and increased the combined frequency of benign and malignant kidney tumors (renal-tubule adenoma and carcinoma). In mice of both sexes, it also caused cancer of the forestomach (squamous-cell carcinoma) and increased the combined incidence of benign and malignant lung tumors (alveolar/bronchiolar adenoma and carcinoma) (NTP 1996).

Cancer Studies in Humans

Two epidemiological cohort studies evaluated the risk of cancer among workers in plants manufacturing anthraquinone dyes; however, it is not known whether workers were exposed specifically to ADBAQ (Gardiner *et al.* 1982, Delzell *et al.* 1989). Some evidence suggests that anthraquinone-dye workers may have an increased risk of cancer. Significant excesses of esophageal and prostate cancer occurred among workers in some areas of an anthraquinone-dyestuffs plant in Scotland, and excesses of lung and central-nervous-system cancer occurred among workers at a New Jersey anthraquinone dye and epichlorohydrin plant (Barbone *et al.* 1992, 1994, Sathiakumar and Delzell 2000). Nevertheless, estimates of risk in all studies were based on small numbers of cancer deaths, and workers may have been exposed to other carcinogens.

Studies on Mechanisms of Carcinogenesis

ADBAQ is rapidly absorbed from the gastrointestinal tract and distributed to most soft tissues. The majority of ADBAQ is metabolized, and both ADBAQ and its metabolites are excreted in the feces and urine. However, the metabolites of ADBAQ have not been identified (NTP 1996). Evaluation of ADBAQ's genetic effects has been hindered by its limited solubility. ADBAQ caused mutations in some strains of bacteria but not in cultured rodent cells, which were tested at lower concentrations (Haworth *et al.* 1983, NTP 1996). In cultured mammalian cells, ADBAQ caused chromosomal aberrations and sister chromatid exchange; however, the results varied among laboratories and among trials at the same laboratory (Loveday *et al.* 1990, NTP 1996). Point mutations in the *ras* proto-oncogene occurred at a higher frequency in forestomach and lung tumors from the two-year carcinogenicity study of ADBAQ-exposed mice than in spontaneous tumors from control mice not exposed to ADBAQ. The predominant types of mutations were A to T transversions and A to G transitions, suggesting that ADBAQ or its metabolites target adenine bases in the *ras* proto-oncogene (Hayashi *et al.* 2001).

The mechanism by which ADBAQ causes cancer is not known. Four other anthraquinones (2-aminoanthraquinone, 1-amino-2-methylanthraquinone, danthron [1,8-dihydroxyanthraquinone], and disperse blue 1 [1,4,5,8-tetraaminoanthraquinone]) are listed in the Report on Carcinogens as *reasonably anticipated to be a human carcinogen*. There is no evidence to suggest that mechanisms by which ADBAQ causes tumors in experimental animals would not also operate in humans.

Properties

ADBAQ is an anthraquinone-derived vat dye that is a reddish-brown to orange powder at room temperature (NTP 1996). It is insoluble in water, making it a colorfast dye. Physical and chemical properties of ADBAQ are listed in the following table.

Property	Information
Molecular weight	381[a]
Melting point	221°C[a]
Log K_{ow}	5.31[b]
Water solubility	0.000015 g/L at 25°C[b]
Vapor pressure	1.44×10^{-7} mm Hg at 25°C[b]

Sources: [a]HSDB 2009, [b]ChemIDplus 2009.

Use

ADBAQ and other aminoanthraquinones are key intermediates in the production of almost all anthraquinone dyes (HSDB 2009). Anthraquinones, including ADBAQ, are widely used as starting material for the manufacture of vat dyes, which are a class of water-insoluble dyes that can easily be reduced to a water-soluble and usually colorless form. In this form, they are readily impregnated into fibers and textiles. Oxidation then produces an insoluble colored form that is remarkably fast to washing, light, and chemicals. Vat dyes typically are used with cotton, wool, and cellulose acetate (NTP 1996).

Production

ADBAQ is prepared from 1-aminoanthraquinone by bromination in dilute mineral acids (HSDB 2009). In 2009, ADBAQ was produced by one manufacturer in China and was available from at least five U.S. suppliers (SRI 2009, ChemSources 2009). In 1991, U.S. production of all vat dyes totaled 14 million kilograms (31 million pounds) (NTP 1996).

Exposure

The primary route of potential exposure to ADBAQ is through dermal contact. Because ADBAQ has a very low vapor pressure, inhalation exposure to vapor is unlikely; however, contaminated dust particles could be inhaled. ADBAQ is not known to be formed naturally in the environment, but may be released into the environment during its production or through its use in the production of anthraquinone dyes. ADBAQ was detected in raw wastewater of a dye manufacturing plant in four of eight samples, at concentrations of 92 to 170 ppb. However, it was not detected in the final effluent before its release into a nearby river or in sediments from the river, which suggests that ADBAQ may have been biodegraded or adsorbed to sludge during wastewater treatment (HSDB 2009). No information was found on occupational exposure specifically to ADBAQ or to anthraquinone dyes in general; however, epidemiological studies indicated occupa-

tional exposure to anthraquinone dyes in a New Jersey dye and resin manufacturing plant (Sathiakumar and Delzell 2000).

Regulations

Environmental Protection Agency (EPA)

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements.

References

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