

## CHAPTER 8. REFERENCES

- Appleton HT, Sikka HC. 1980. Accumulation, elimination, and metabolism of dichlorobenzidine in the bluegill sunfish. *Environ Sci Technol* 14(1):50-54. <http://doi.org/10.1021/es60161a005>.
- Araki N, Ohno K, Nakai M, et al. 2005. Screening for androgen receptor activities in 253 industrial chemicals by in vitro reporter gene assays using AR-EcoScreen cells. *Toxicol In Vitro* 19(6):831-842. <http://doi.org/10.1016/j.tiv.2005.04.009>.
- Armentrout DN, Cutie SS. 1980. Determination of benzidine and 3,3'-dichlorobenzidine in wastewater by liquid chromatography with UV and electrochemical detection. *J Chromatogr Sci* 18(8):370-374. <http://doi.org/10.1093/chromsci/18.8.370>.
- Ashby J, Mohammed R. 1988. UDS activity in the rat liver of the human carcinogens benzidine and 4-aminobiphenyl, and the rodent carcinogens 3,3'-dichlorobenzidine and direct black 38. *Mutagenesis* 3(1):69-71. <http://doi.org/10.1093/mutage/3.1.69>.
- ATSDR. 1989. Decision guide for identifying substance-specific data needs related to toxicological profiles; Notice. Agency for Toxic Substances and Disease Registry. *Fed Regist* 54(174):37518-37634.
- ATSDR. 1996. Public Health Assessment for Bofors Nobel Incorporated, Egelston Township, Muskegon County, Michigan, Region 5. Atlanta, GA: Agency for Toxic Substances and Disease Registry. PB96202056. CERCLIS No. MID006030373.
- ATSDR. 2019. Full SPL data. Substance priority list (SPL) resource page. Agency for Toxic Substances and Disease Registry. <http://www.atsdr.cdc.gov/SPL/resources>. November 6, 2019.
- Banerjee S, Sikka HC, Gray R. 1978. Photodegradation of 3,3'-dichlorobenzidine. *Environ Sci Technol* 12(13):1425-1427. <http://doi.org/10.1021/es60148a012>.
- Belman S, Troll W, Teebor G, et al. 1968. The carcinogenic and mutagenic properties of N-hydroxy-aminonaphthalenes. *Cancer Res* 28(3):535-542.
- Berry DF, Boyd SA. 1985. Decontamination of soil through enhanced formation of bound residues. *Environ Sci Technol* 19:1132-1133.
- Birner G, Albrecht W, Neumann HG. 1990. Biomonitoring of aromatic amines. III: Hemoglobin binding of benzidine and some benzidine congeners. *Arch Toxicol* 64(2):97-102.
- Bowman MC, Nony CR. 1981. Possible carcinogenic metabolites of azo dye and pigment: trace-level determination of benzidine, 3,3'-dichlorobenzidine and their acetylated and conjugated products in human and hamster urine. *IARC Sci Publ* (40):193-217.
- Bowman MC, Rushing LG. 1981. Trace-level determination of 3,3'-dichlorobenzidine in animal chow, wastewater and human urine by gas chromatographic procedures. *IARC Sci Publ* (40):159-174.
- Boyd SA, Kao CW, Suflita JM. 1984. Fate of 3,3'-dichlorobenzidine in soil: Persistence and binding. *Environ Tox Chem* 3:201-208.
- Bratcher SC, Sikka HC. 1982. Binding of 3,3'-dichlorobenzidine to DNA and polyribonucleotides in vitro. *Chem Biol Interact* 38(3):369-375. [http://doi.org/10.1016/0009-2797\(82\)90066-7](http://doi.org/10.1016/0009-2797(82)90066-7).
- Brown D, Laboureur P. 1983. The aerobic biodegradability of primary aromatic amines. *Chemosphere* 12(3):405-414. [http://doi.org/10.1016/0045-6535\(83\)90115-7](http://doi.org/10.1016/0045-6535(83)90115-7).
- Cao X, Junli H, Chongwei C, et al. 2007. Benzidines in tannery dye wastewater: Oxidative degradation by chlorine dioxide. *J Soc Leather Technol Chem* 91(4):145-148.
- Casero I, Sicilia D, Rubio S, et al. 1997. Chemical degradation of aromatic amines by Fenton's reagent. *Water Res* 31(8):1985-1995. [http://doi.org/10.1016/s0043-1354\(96\)00344-2](http://doi.org/10.1016/s0043-1354(96)00344-2).
- CDR. 2016. Chemical data reporting. U.S. Environmental Protection Agency. <https://www.epa.gov/chemical-data-reporting/2016-chemical-data-reporting-results>. December 15, 2021.
- Chen SC, Kao CM, Huang MH, et al. 2003. Assessment of genotoxicity of benzidine and its structural analogues to human lymphocytes using comet assay. *Toxicol Sci* 72(2):283-288. <http://doi.org/10.1093/toxsci/kfg026>.

## 8. REFERENCES

- Chen LC, Wu JC, Tuan YF, et al. 2014. Molecular mechanisms of 3,3'-dichlorobenzidine-mediated toxicity in HepG2 cells. *Environ Mol Mutagen* 55(5):407-420. <http://doi.org/10.1002/em.21858>.
- Chung DY, Boyd SA. 1987. Mobility of sludge-borne 3,3-dichlorobenzidine in soil columns. *J Environ Qual* 16(2):147-151. <http://doi.org/10.2134/jeq1987.00472425001600020010x>.
- Chung KT, Chen SC, Wong TY, et al. 2000. Mutagenicity studies of benzidine and its analogs: structure-activity relationships. *Toxicol Sci* 56(2):351-356. <http://doi.org/10.1093/toxsci/56.2.351>.
- Cihak R, Vontorkova M. 1987. Benzidine and 3,3'-dichlorobenzidine (DCB) induce micronuclei in the bone marrow and the fetal liver of mice after gavage. *Mutagenesis* 2(4):267-269. <http://doi.org/10.1093/mutage/2.4.267>.
- Claxton LD, Hughes TJ, Chung KT. 2001. Using base-specific Salmonella tester strains to characterize the types of mutation induced by benzidine and benzidine congeners after reductive metabolism. *Food Chem Toxicol* 39(12):1253-1261. [http://doi.org/10.1016/s0278-6915\(01\)00072-2](http://doi.org/10.1016/s0278-6915(01)00072-2).
- Clewell HJ, Andersen ME. 1985. Risk assessment extrapolations and physiological modeling. *Toxicol Ind Health* 1(4):111-131. <http://doi.org/10.1177/074823378500100408>.
- CPMA. 1998. Urinalysis for 3,3'-dichlorobenzidine. Re: Comments of the Color Pigments Manufacturers Association, Inc. on the Agency for Toxic Substances and Disease Registry draft toxicological profile for 3,3'-dichlorobenzidine (CAS# 00091-94-1), docket control number ATSDR-128 [Comment on: draft toxicological profile for 3,3'-dichlorobenzidine]. Alexandria, VA: Color Pigments Manufacturers Association, Inc.
- Dapson RW. 2009. Benzidine-based dyes: effects of industrial practices, regulations, and world trade on the biological stains market. *Biotech Histochem* 84(3):95-100. <http://doi.org/10.1080/10520290902879730>.
- DCMA. 1989. Re: docket control no. ATSDR-7 draft toxicological profile for 3,3'-dichlorobenzidine [Comment on: draft toxicological profile for 3,3'-dichlorobenzidine]. Alexandria, VA: Dry Color Manufacturers' Association.
- Demirjian YA, Westman TR, Joshi AM, et al. 1984. Land treatment of contaminated sludge with wastewater irrigation. *J Water Pollut Control Fed* 56(4):370-377.
- Diachenko GW. 1979. Determination of several aromatic amines in fish. *Environ Sci Technol* 13(3):329-333.
- DOE. 2016. Protective action criteria (PAC): Chemicals with AEGLs, ERPGs, & TEELs. Definition of PACs (AEGLs, ERPGs or TEELs). Oak Ridge, TN: U.S. Department of Energy. <https://edms.energy.gov/pac/TeelDef>. December 15, 2021.
- DOE. 2018. Table 3: Protective Action Criteria (PAC) Rev. 29a based on applicable 60-minute AEGLs, ERPGs, or TEELs. The chemicals are listed by CASRN. June 2018. Oak Ridge, TN: U.S. Department of Energy. [https://edms3.energy.gov/pac/docs/Revision\\_29A\\_Table3.pdf](https://edms3.energy.gov/pac/docs/Revision_29A_Table3.pdf). December 15, 2021.
- Donaldson FP, Nyman MC. 2005. Sorption of benzidine and 3,3'-dichlorobenzidine to lake sediments. I. Conceptualization and development of a multiparameter model. *Environ Toxicol Chem* 24(5):1022-1028. <http://doi.org/10.1897/04-264r.1>.
- EPA. 1978a. Reviews of the environmental effects of pollutants. II. Benzidine. Cincinnati, OH: U.S. Environmental Protection Agency. EPA600178024. ORNL/EIS-86. <https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100SICZ.txt>. May 11, 2022.
- EPA. 1978b. Fate of 3,3'-dichlorobenzidine in aquatic environments. Athens, GA: U.S. Environmental Protection Agency. EPA600378068. May 11, 2022.
- EPA. 1979. Water-related environmental fate of 129 priority pollutants. Volume 1: Introduction and technical background, metals and inorganics, pesticides and PCBs. Washington, DC: U.S. Environmental Protection Agency. EPA440479029b.
- EPA. 1980a. Ambient water quality criteria for dichlorobenzidine. Washington, DC: U.S. Environmental Protection Agency. EPA440580040. PB81117517. <https://www.epa.gov/sites/production/files/2019-03/documents/ambient-wqc-dichlorobenzidine-1980.pdf>. December 15, 2021.

## 8. REFERENCES

- EPA. 1980b. Treatability manual. Volume I. Treatability data. Washington, DC: U.S. Environmental Protection Agency. <https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20008BPO.TXT>. December 15, 2021.
- EPA. 1982. Aquatic fate process data for organic priority pollutants. Washington, DC: U.S. Environmental Protection Agency. EPA440481014.
- EPA. 2003. Applicability of treatment standards. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 268.40. <https://www.govinfo.gov/app/details/CFR-2003-title40-vol24/CFR-2003-title40-vol24-sec268-40>. December 19, 2021.
- EPA. 2005. Toxic chemical release inventory reporting forms and instructions: Revised 2004 version. Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986). U.S. Environmental Protection Agency. EPA260B05001.
- EPA. 2009. National primary drinking water regulations. U.S. Environmental Protection Agency. EPA816F090004. [https://www.epa.gov/sites/production/files/2016-06/documents/npwdr\\_complete\\_table.pdf](https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf). September 7, 2017.
- EPA. 2010. Dyes derived from benzidine and its congeners. U.S. Environmental Protection Agency. [https://www.epa.gov/sites/production/files/2015-09/documents/dcb\\_action\\_plan\\_06232010.noheader.pdf](https://www.epa.gov/sites/production/files/2015-09/documents/dcb_action_plan_06232010.noheader.pdf). December 15, 2021.
- EPA. 2011. Discarded commercial chemical products, off-specification species, container residues, and spill residues thereof. Code of Federal Regulations. U.S. Environmental Protection Agency. 40 CFR 261.33. <https://www.govinfo.gov/content/pkg/CFR-2011-title40-vol26/pdf/CFR-2011-title40-vol26-sec261-33.pdf>. December 19, 2021.
- EPA. 2014. Technical appendix B. Physicochemical properties for TRI chemicals and chemical categories. U.S. Environmental Protection Agency. [https://www.epa.gov/sites/production/files/2014-03/documents/tech\\_app\\_b\\_v212.pdf](https://www.epa.gov/sites/production/files/2014-03/documents/tech_app_b_v212.pdf). December 15, 2021.
- EPA. 2015. List of lists: Consolidated list of chemicals subject to the Emergency Planning and Community Right to Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and section 112(r) of the Clean Air Act. U.S. Environmental Protection Agency. EPA550B15001.
- EPA. 2018a. Compiled AEGL values. U.S. Environmental Protection Agency. [https://www.epa.gov/sites/production/files/2018-08/documents/compiled\\_aegls\\_update\\_27jul2018.pdf](https://www.epa.gov/sites/production/files/2018-08/documents/compiled_aegls_update_27jul2018.pdf). December 15, 2021.
- EPA. 2018b. 2018 Edition of the drinking water standards and health advisories tables. Washington, DC: U.S. Environmental Protection Agency. EPA822F18001. <https://semspub.epa.gov/work/HQ/100002014.pdf>. March 1, 2022.
- FDA. 2021. Substances added to food. U.S. Food and Drug Administration. <https://www.cfsanappsexternal.fda.gov/scripts/fdcc/?set=FoodSubstances>. February 3, 2021.
- Freitag D, Ballhorn L, Geyer H, et al. 1985. Environmental hazard profile of organic chemicals: An experimental method for the assessment of the behaviour of organic chemicals in the ecosphere by means of simple laboratory tests with <sup>14</sup>C labelled chemicals. *Chemosphere* 14(10):1589-1616. [http://doi.org/10.1016/0045-6535\(85\)90014-1](http://doi.org/10.1016/0045-6535(85)90014-1).
- Fricke C, Clarkson C, Lomnitz E, et al. 1985. Comparing priority pollutants in municipal sludges. *Biocycle* 26:35-37.
- Gadian T. 1975. Carcinogens in industry, with special reference to dichlorobenzidine. *Chem Ind* 19:21-831.
- Garner RC, Walpole AL, Rose FL. 1975. Testing of some benzidine analogues for microsomal activation to bacterial mutagens. *Cancer Lett* 1:39-42. [http://doi.org/10.1016/s0304-3835\(75\)94960-5](http://doi.org/10.1016/s0304-3835(75)94960-5).
- Gerarde HW, Gerarde DF. 1974. Industrial experience with 3,3'-dichlorobenzidine: an epidemiological study of a chemical manufacturing plant. *J Occup Med* 16(5):322-335.

## 8. REFERENCES

- Ghosal A, Iba MM. 1990. In vivo binding of 3,3'-dichlorobenzidine to rat and mouse tissue DNA. *Cancer Lett* 53(2-3):197-204. [http://doi.org/10.1016/0304-3835\(90\)90214-i](http://doi.org/10.1016/0304-3835(90)90214-i).
- Ghosal A, Iba MM. 1992. Enhancement by butylated hydroxytoluene of the in vitro activation of 3,3'-dichlorobenzidine. *Mutat Res* 278(1):31-41. [http://doi.org/10.1016/0165-1218\(92\)90283-6](http://doi.org/10.1016/0165-1218(92)90283-6).
- Golub NI. 1969. Transplacental action of 3,3'-dichlorobenzidine and orthotolidine on organ cultures of embryonic mouse kidney tissue. *Bull Exp Biol Med* 68(5):1280-1283. <http://doi.org/10.1007/bf00787434>.
- Golub NI, Kolesnichenko TS, Shabad LM. 1975. Oncogenic action of some nitrogen compounds on the progeny of experimental mice. *Bull Exp Biol Med* 78(6):1402-1404. <http://doi.org/10.1007/bf00808717>.
- Government of Canada. 1993. Canadian environmental protection act. Priority substances list assessment report. 3,3'-dichlorobenzidine. Government of Canada. [https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt\\_formats/hecs-sesc/pdf/pubs/contaminants/psl1-lsp1/3-dichlorobenzidine/3-dichlorobenzidine-eng.pdf](https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/contaminants/psl1-lsp1/3-dichlorobenzidine/3-dichlorobenzidine-eng.pdf). May 11, 2022.
- Graveel JG, Sommers LE, Nelson DW. 1986. Decomposition of benzidine, a-naphthylamine, and p-toluidine in soils. *J Environ Qual* 15(1):53-59. <http://doi.org/10.2134/jeq1986.00472425001500010013x>.
- Grifoll M, Solanas AM, Bayona JM. 1992. Bioassay-directed chemical characterization of genotoxic agents in the dissolved and particulate water phases of the Besos and Llobregat Rivers (Barcelona, Spain). *Arch Environ Contam Toxicol* 23(1):19-25. <http://doi.org/10.1007/BF00225991>.
- Griswold DP, Casey AE, Weisburger EK, et al. 1968. The carcinogenicity of multiple intragastric doses of aromatic and heterocyclic nitro or amino derivatives in young female Sprague-Dawley rats. *Cancer Res* 28(5):924-933.
- Guerbet M, Brisorgueil E, Jolibois B, et al. 2007. Evaluation of urinary mutagenicity in azo dye manufacture workers. *Int J Occup Med Environ Health* 20(2):137-145. <http://doi.org/10.2478/v10001-007-0014-4>.
- Hailong X, Fen Q, Ying X, et al. 2014. A rapid and sensitive method for the detection of aromatic amines in cosmetics. *J Chromatogr Sci* 52(2):115-119. <http://doi.org/10.1093/chromsci/bms254>.
- Harden J, Donaldson FP, Nyman MC. 2005. Concentrations and distribution of 3,3'-dichlorobenzidine and its congeners in environmental samples from Lake Macatawa. *Chemosphere* 58(6):767-777. <http://doi.org/10.1016/j.chemosphere.2004.09.081>.
- Hatfield TR, Roberts EC, Bell IF, et al. 1982. Urine monitoring of textile workers exposed to dichlorobenzidine-derived pigments. *J Occup Med* 24(9):656-658. <http://doi.org/10.1097/00043764-198209000-00010>.
- Hauri U, Hohl C. 2015. Photostability and breakdown products of pigments currently used in tattoo inks. *Curr Probl Dermatol* 48:164-169. <http://doi.org/10.1159/000369225>.
- Hering H, Sung AY, Roder N, et al. 2018. Laser irradiation of organic tattoo pigments releases carcinogens with 3,3'-dichlorobenzidine inducing DNA strand breaks in human skin cells. *J Invest Dermatol* 138(12):2687-2690. <http://doi.org/10.1016/j.jid.2018.05.031>.
- Hofmann T, Schmidt D. 1993. Investigation of possible metabolism of pigment yellow 17, a 3,3'-dichlorobenzidine-based pigment, after inhalation exposure in rats. *Arch Toxicol* 67(2):141-144. <http://doi.org/10.1007/BF01973685>.
- Howard PH, Boethling RS, Jarvis WF, et al. 1991. 3,3'-Dichlorobenzidine. In: Printup HT, ed. *Handbook of environmental degradation rates*. Boca Raton, FL: Lewis Publishers, Inc, 266-267.
- Hsu RS, Sikka HC. 1982. Disposition of 3,3'-dichlorobenzidine in the rat. *Toxicol Appl Pharmacol* 64(2):306-316. [http://doi.org/10.1016/0041-008x\(82\)90225-3](http://doi.org/10.1016/0041-008x(82)90225-3).
- IARC. 1987. IARC monographs on the evaluation of carcinogenic risks to humans. Supplement 7, overall evaluation of carcinogenicity: An updating of IARC monographs (volumes 1 to 42). Lyon, France: International Agency for Research on Cancer.

## 8. REFERENCES

- Iba MM. 1987. Comparative activation of 3,3'-dichlorobenzidine and related benzidines to mutagens in the *Salmonella typhimurium* assay by hepatic S9 and microsomes from rats pretreated with different inducers of cytochrome P-450. *Mutat Res* 182(5):231-241. [http://doi.org/10.1016/0165-1161\(87\)90009-4](http://doi.org/10.1016/0165-1161(87)90009-4).
- Iba MM. 1989. Activation of 3,3'-dichlorobenzidine: enzymic basis and toxicological consequences. *Drug Metab Rev* 21(3):377-400. <http://doi.org/10.3109/03602538909030303>.
- Imaoka S, Yoneda Y, Matsuda T, et al. 1997. Mutagenic activation of urinary bladder carcinogens by CYP4B1 and the presence of CYP4B1 in bladder mucosa. *Biochem Pharmacol* 54(6):677-683. [http://doi.org/10.1016/s0006-2952\(97\)00216-5](http://doi.org/10.1016/s0006-2952(97)00216-5).
- IRIS. 2006. 3,3'-Dichlorobenzidine; CASRN 91-94-1. Integrated Risk Information System. Chemical assessment summary. U.S. Environmental Protection Agency. [https://iris.epa.gov/static/pdfs/0504\\_summary.pdf](https://iris.epa.gov/static/pdfs/0504_summary.pdf). January 11, 2022.
- Ito N, Fukushima S, Shirai T, et al. 1983. Modifying factors in urinary bladder carcinogenesis. *Environ Health Perspect* 49:217-222. <http://doi.org/10.1289/ehp.8349217>.
- Joppich-Kuhn R, Hanggi R, Sagelsdorff P, et al. 1997. Determination of dichlorobenzidine-hemoglobin adducts by GC/MS-NCI. *Int Arch Occup Environ Health* 69(4):240-246. <http://doi.org/10.1007/s004200050142>.
- Knoell KF, Will N, Leng G, et al. 2012. Development of a strategy for biological monitoring in a chemical plant producing 3,3'-dichlorobenzidine dihydrochloride. *J Toxicol Environ Health A* 75(8-10):551-556. <http://doi.org/10.1080/15287394.2012.675307>.
- Krishnan K, Andersen ME. 1994. Physiologically-based pharmacokinetic modeling in toxicology. In: Hayes W, ed. *Principles and methods of toxicology*. 3rd ed. New York, NY: Raven Press Ltd, 149-188.
- Law RJ. 1995. 3,3'-Dichlorobenzidine: a candidate for inclusion in marine monitoring programmes? *Chemosphere* 30(9):1791-1797. [http://doi.org/10.1016/0045-6535\(95\)00063-e](http://doi.org/10.1016/0045-6535(95)00063-e).
- Lazear EJ, Shaddock JG, Barren PR, et al. 1979. The mutagenicity of some of the proposed metabolites of direct black 38 and pigment yellow 12 in the *Salmonella typhimurium* assay system. *Toxicol Lett* 4(6):519-525. [http://doi.org/10.1016/0378-4274\(79\)90120-6](http://doi.org/10.1016/0378-4274(79)90120-6).
- Lee JH, Shin HS. 2002. Determination of hemoglobin adducts formed in rats exposed orally with 3,3'-dichlorobenzidine by GC/MS-SIM. *Toxicol Ind Health* 18(4):191-199. <http://doi.org/10.1191/0748233702th142oa>.
- Lee JH, Shin HS, Jung DG, et al. 2003. Urinary monitoring method of 3,3'-dichlorobenzidine (DCB) and its metabolites, N-acetyl-DCB and N,N'-diacetyl-DCB. *Ind Health* 41(3):242-248. <http://doi.org/10.2486/indhealth.41.242>.
- Lee HB, Peart TE, Terry K, et al. 2004. Determination of 3,3'-dichlorobenzidine in industrial wastewaters. *Water Qual Res J Canada* 23(1):29-34.
- Leuschner F. 1978. Carcinogenicity studies on different diarylide yellow pigments in mice and rats. *Toxicol Lett* 2(5):253-260. [http://doi.org/10.1016/0378-4274\(78\)90022-x](http://doi.org/10.1016/0378-4274(78)90022-x).
- Litepllo RG, Meek ME. 1994. 3,3'-Dichlorobenzidine: Evaluation of risks to health from environmental exposure in Canada. *J Environ Sci Health C* 12(2):287-292. <http://doi.org/10.1080/10590509409373447>.
- Lopez-Avila V, Haile CL, Goddard PR, et al. 1981. Development of methods for the analysis of extractable organic priority pollutants in municipal and industrial wastewater treatment sludges. In: Keith L, ed. *Advances in the identification and analysis of organic pollutants in water*. Vol. 2. Ann Arbor, MI: Ann Arbor Science Publishers, 793-828.
- MacIntyre DI. 1975. Experience of tumors in a British plant handling 3 3' dichlorobenzidine. *J Occup Med* 17(1):23-26.
- Mackay D, Paterson S. 1991. Evaluating the multimedia fate of organic chemicals: a level III fugacity model. *Environ Sci Technol* 25(3):427-436. <http://doi.org/10.1021/es00015a008>.

## 8. REFERENCES

- Makena P, Chung KT. 2007. Evidence that 4-aminobiphenyl, benzidine, and benzidine congeners produce genotoxicity through reactive oxygen species. *Environ Mol Mutagen* 48(5):404-413. <http://doi.org/10.1002/em.20288>.
- Maner A, Bavikar S, Sudalai A, et al. 2009. Process for the preparation of high quality 3,3',4,4'-tetraminobiphenyl. European Patent Office. Patent No. EP1727781B1. <https://patents.google.com/patent/EP1727781B1/en>.
- Meigs JW, Sciarini LJ, Van Sandt WA. 1954. Skin penetration by diamines of the benzidine group. *AMA Arch Ind Hyg Occup Med* 9(2):122-132.
- Millerick-May ML, Wang L, Rice C, et al. 2021. Ongoing risk of bladder cancer among former workers at the last benzidine manufacturing facility in the USA. *Occup Environ Med* 78(9):625-631. <http://doi.org/10.1136/oemed-2020-106431>.
- Mizuno T, Takamura-Enya T, Watanabe T, et al. 2007. Quantification of a potent mutagenic 4-amino-3,3'-dichloro-5,4'-dinitrobiphenyl (ADDB) and the related chemicals in water from the Waka River in Wakayama, Japan. *Mutat Res* 630(1-2):112-121. <http://doi.org/10.1016/j.mrgentox.2007.03.004>.
- Morita T, Asano N, Awogi T, et al. 1997. Evaluation of the rodent micronucleus assay in the screening of IARC carcinogens (groups 1, 2A and 2B) the summary report of the 6th collaborative study by CSGMT/JEMS MMS. Collaborative Study of the Micronucleus Group Test. Mammalian Mutagenicity Study Group. *Mutat Res* 389(1):3-122. [http://doi.org/10.1016/s1383-5718\(96\)00070-8](http://doi.org/10.1016/s1383-5718(96)00070-8).
- MWRA. 2015. Industrial waste report: FY 2015 annual report. Massachusetts Water Resources Authority. Industrial Waste Report #31. <https://www.mwra.com/annual/tracindustrialwastereport/iwr-2015.pdf>. December 15, 2021.
- Myslak ZW, Bolt HM, Brockmann W. 1991. Tumors of the urinary bladder in painters: a case-control study. *Am J Ind Med* 19(6):705-713. <http://doi.org/10.1002/ajim.4700190604>.
- Narang AS, Choudhury DR, Richards A. 1982. Separation of aromatic amines by thin-layer and high-performance liquid chromatography. *J Chromatogr Sci* 20:235-237.
- NAS/NRC. 1989. Report of the oversight committee. Biologic markers in reproductive toxicology. Washington, DC: National Academy of Sciences, National Research Council, National Academy Press. 15-35.
- NCTR. 1979. Metabolism of azo dyes to potentially carcinogenic amines. Jefferson, AR: National Center for Toxicological Research. NCTR Technical Report for Experiment No. 196.
- NIOSH. 1986a. Health hazard evaluation report: HETA 80-035-1635: Bofors-Nobel/Lakeway Corporation, Muskegon, Michigan. Cincinnati, OH: National Institute for Occupational Safety and Health. HETA 80-035-1635. PB86205739. <https://ntrlntris.gov/NTRL/dashboard/searchResults/titleDetail/PB86205739.xhtml>.
- NIOSH. 1986b. Health hazard evaluation report: HETA 84-058-1700: Hilton-Davis Chemical Company, Cincinnati, Ohio. Cincinnati, OH: National Institute for Occupational Safety and Health. HETA 84-058-1700. PB87105565.
- NIOSH. 2019. 3,3'-Dichlorobenzidine (and its salts). CDC-NIOSH pocket guide to chemical hazards. National Institute for Occupational Safety and Health. <https://www.cdc.gov/niosh/npg/npgd0191.html>. July 23, 2020.
- NIOSH. 2020. Benzidine and 3,3'-dichlorobenzidine. NIOSH manual of analytical methods (NMAM), 5th edition. Cincinnati, OH: National Institute for Occupational Safety and Health. Method 5509. [https://www.cdc.gov/niosh/nmam/pdf/NMAM\\_5thEd\\_EBook-508-final.pdf](https://www.cdc.gov/niosh/nmam/pdf/NMAM_5thEd_EBook-508-final.pdf). May 10, 2022.
- NLM. 2019. PubChem: Compound summaries [3,3'-Dichlorobenzidine; 3,3'-Dichlorobenzidine dihydrochloride; 3,3'-Dichlorobenzidine sulfate]. U.S. National Library of Medicine. <https://pubchem.ncbi.nlm.nih.gov/>. April 22, 2019.
- Nony CR, Bowman MC. 1980. Trace analysis of potentially carcinogenic metabolites of an azo dye and pigment in hamster and human urine as determined by two chromatographic procedures. *J Chromatogr Sci* 18(2):64-74.

## 8. REFERENCES

- Nony CR, Bowman MC, Cairns T, et al. 1980. Metabolism studies of an azo dye and pigment in the hamster based on analysis of the urine for potentially carcinogenic aromatic amine metabolites. *J Anal Toxicol* 4(3):132-140. <http://doi.org/10.1093/jat/4.3.132>.
- NTP. 1991. 3,3'-dichlorobenzidine and 3,3'-dichlorobenzidine dihydro-chloride CAS Nos.91-94-1 and 612-83-9. Report on carcinogens. Sixth edition. Research Triangle Park, NC: National Toxicology Program. 159-161.
- NTP. 2016. Report on carcinogens. Fourteenth edition. Research Triangle Park, NC: National Toxicology Program.
- NTP. 2021. 3,3'-Dichlorobenzidine and its dihydrochloride. In: Report on carcinogens. 15th ed. National Toxicology Program, <https://ntp.niehs.nih.gov/ntp/roc/content/profiles/dichlorobenzidine.pdf>. January 11, 2022.
- Nyman MC, Nyman AK, Lee LS, et al. 1997. 3,3'-Dichlorobenzidine transformation processes in natural sediments. *Environ Sci Technol* 31(4):1068-1073. <http://doi.org/10.1021/es960571k>.
- Nyman MC, Perez J, Blatchley ER, et al. 1999. Determination of 3,3'-dichlorobenzidine and its degradation products in environmental samples with a small low-field Fourier transform ion cyclotron resonance mass spectrometer. *J Am Soc Mass Spectrom* 10(11):1152-1156. [http://doi.org/10.1016/S1044-0305\(99\)00080-X](http://doi.org/10.1016/S1044-0305(99)00080-X).
- Nyman MC, Haber KS, Kenttamaa HI, et al. 2002. Photodechlorination of 3,3'-dichlorobenzidine in water. *Environ Toxicol Chem* 21(3):500-506.
- Nyman MC, McCord K, Wood WL, et al. 2003. Transport behavior of 3,3'-dichlorobenzidine in a freshwater estuary. *Environ Toxicol Chem* 22(1):20-25.
- Nyman MC, Harden J, Nies LF, et al. 2004. Biodegradation of 3,3'-dichlorobenzidine in freshwater lake sediments. *J Environ Eng Sci* 3(2):89-95. <http://doi.org/10.1139/s03-057>.
- Ohe T, Watanabe T, Nonouchi Y, et al. 2008. Identification of a new mutagen, 4,4'-diamino-3,3'-dichloro-5-nitrobiphenyl, in river water flowing through an industrial area in Wakayama, Japan. *Mutat Res* 655(1-2):28-35. <http://doi.org/10.1016/j.mrgentox.2008.06.008>.
- Onuska FI, Terry KA, Maguire RJ. 2000. Analysis of aromatic amines in industrial wastewater by capillary gas chromatography-mass spectrometry. *Water Qual Res J Canada* 35(2):245-261.
- Osanai H. 1976. [An experimental study on hepatoma caused by aromatic amines]. *Rodo Kagaku* 52(4):179-201. (Japanese)
- OSHA. 2021a. Occupational safety and health standards. Subpart Z - Toxic and hazardous substances. Air contaminants. Table Z-1: Limits for air contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 CFR 1910.1000. <https://www.osha.gov/laws-regulations/standardnumber/1910/1910.1000TABLEZ1>. September 28, 2020.
- OSHA. 2021b. 13 Carcinogens (4-nitrobiphenyl, etc.). Occupational Safety and Health Administration. Code of Federal Regulations. 29 CFR 1910.1003. <https://www.ecfr.gov/on/2021-12-31/title-29/subtitle-B/chapter-XVII/part-1910/subpart-Z/section-1910.1003>. January 11, 2022.
- Ouellet-Hellstrom R, Rench JD. 1996. Bladder cancer incidence in arylamine workers. *J Occup Environ Med* 38(12):1239-1247. <http://doi.org/10.1097/00043764-199612000-00009>.
- Paraiba LC, Boeira R, Jonsson CM, et al. 2006. [Bioconcentration factor of organic pollutants of the sewage sludge in orange fruits]. *Pesticidas* 16:125-134. (Portuguese)
- Pliss GB. 1959. 3,3'-Dichlorobenzidine as a blastomogenic agent. *Vopr Onkol* 5(5):524-533.
- Pliss GB. 1963. On some regular relationship between carcinogenicity of aminodiphenyl derivatives and the structure of substance. *Acta Unio Int Contra Cancrum* 19:499-501.
- Reid TM, Morton KC, Wang CY, et al. 1984. Mutagenicity of azo dyes following metabolism by different reductive/oxidative systems. *Environ Mutagen* 6(5):705-717. <http://doi.org/10.1002/em.2860060508>.
- RePORTER. 2021. 3,3'-Dichlorobenzidine. Research Portfolio Online Reporting Tools. National Institute of Health. <https://projectreporter.nih.gov/>. June 24, 2021.

## 8. REFERENCES

- Riggin RM, Howard CC, Scott DR, et al. 1983. Determination of benzidine, related congeners, and pigments in atmospheric particulate matter. *J Chromatogr Sci* 21(7):321-325. <http://doi.org/10.1093/chromsci/21.7.321>.
- Roberts EC, Rossano AJ. 2010. A sensitive colorimetric determination of 3,3'-dichlorobenzidine in urine. *Am Ind Hyg Assoc J* 43(2):80-83. <http://doi.org/10.1080/15298668291409398>.
- Rosenman KD, Reilly MJ. 2004. Cancer mortality and incidence among a cohort of benzidine and dichlorobenzidine dye manufacturing workers. *Am J Ind Med* 46(5):505-512. <http://doi.org/10.1002/ajim.20093>.
- Roy WR, Griffin RA. 1985. Mobility of organic solvents in water-saturated soil materials. *Environ Geol Water Sci* 7(4):241-247. <http://doi.org/10.1007/bf02509925>.
- Saffiotti U, Cefis F, Montesano R, et al. 1967. Induction of bladder cancer in hamsters fed aromatic amines. In: Deichman WL, ed. *Bladder cancer: A symposium*. Birmingham, AL: Aesculapius Publishing Co, 129-135.
- Sasaki YF, Fujikawa K, Ishida K, et al. 1999. The alkaline single cell gel electrophoresis assay with mouse multiple organs: results with 30 aromatic amines evaluated by the IARC and U.S. NTP. *Mutat Res* 440(1):1-18. [http://doi.org/10.1016/s1383-5718\(99\)00006-6](http://doi.org/10.1016/s1383-5718(99)00006-6).
- Savard S, Josephy PD. 1986. Synthesis and mutagenicity of 3,3'-dihalogenated benzidines. *Carcinogenesis* 7(7):1239-1241. <http://doi.org/10.1093/carcin/7.7.1239>.
- Schwenecke H, Mayer D. 2000. Benzidine and benzidine derivatives. In: Ullmann's encyclopedia of industrial chemistry. Wiley-VCH Verlag GmbH & Co, [https://doi.org/10.1002/14356007.a03\\_539](https://doi.org/10.1002/14356007.a03_539). December 15, 2021.
- Shabad LM, Sorokina JD, Golub NI, et al. 1972. Transplacental effect of some chemical compounds on organ cultures of embryonic kidney tissue. *Cancer Res* 32(3):617-627.
- Shah PV, Guthrie FE. 1983. Dermal absorption of benzidine derivatives in rats. *Bull Environ Contam Toxicol* 31(1):73-78. <http://doi.org/10.1007/BF01608769>.
- Shiraishi Y. 1986. Hypersensitive character of Bloom syndrome B-lymphoblastoid cell lines usable for sensitive carcinogen detection. *Mutat Res* 175(3):179-187. [http://doi.org/10.1016/0165-7992\(86\)90119-3](http://doi.org/10.1016/0165-7992(86)90119-3).
- Sparr Eskilsson C, Davidsson R, Mathiasson L. 2002. Harmful azo colorants in leather. Determination based on their cleavage and extraction of corresponding carcinogenic aromatic amines using modern extraction techniques. *J Chromatogr A* 955(2):215-227.
- Staples CA, Werner AF, Hoogheem TJ. 1985. Assessment of priority pollutant concentrations in the United States using the STORET database. *Environ Tox Chem* 4:131-142.
- Stula EF, Sherman H, Zapp JA, Jr., et al. 1975. Experimental neoplasia in rats from oral administration of 3,3'-dichlorobenzidine, 4,4'-methylene-bis-(2-chloroaniline), and 4,4'-methylene-bis-(2-methylaniline). *Toxicol Appl Pharmacol* 31(1):159-176. [http://doi.org/10.1016/0041-008x\(75\)90064-2](http://doi.org/10.1016/0041-008x(75)90064-2).
- Stula EF, Barnes JR, Sherman H, et al. 1978. Liver and urinary bladder tumors in dogs from 3,3'-dichlorobenzidine. *J Environ Pathol Toxicol* 1(4):475-490.
- Suchy FJ. 2014. Functional development of the liver. In: Suchy FJ, Sokol RJ, Balistreri WF, eds. *Liver disease in children*. 4<sup>th</sup> ed. New York, NY: Cambridge University Press, 10-23.
- Tanaka K. 1981. [Urinary metabolites of 3, 3'-dichlorobenzidine and their mutagenicity]. *Sangyo Igaku* 23(4):426-427. (Japanese)
- TRI20. 2021. 3,3'-Dichlorobenzidine. Toxic chemical release inventory. U.S. Environmental Protection Agency. <https://www.epa.gov/enviro/tri-search>. November 8, 2021.
- USGS. 2007. Reconnaissance of soil, ground water, and plant contamination at an abandoned oilfield-service site near Shawnee, Oklahoma, 2005–2006. Reston, VA: U.S. Geological Survey. Report 2007-5131. <http://doi.org/10.3133/sir20075131>.
- USITC. 2021. General first unit of quantity for all countries. General imports. Annual data. U.S. International Trade Commission. <https://dataweb.usitc.gov/trade/search>. December 15, 2021.

## 8. REFERENCES

- Valls M, Bayona JM, Albaiges J. 1990. Broad spectrum analysis of ionic and non-ionic organic contaminants in urban wastewaters and coastal receiving aquatic systems. *Int J Environ Anal Chem* 39(4):329-348. <http://doi.org/10.1080/03067319008030506>.
- Vera-Avila LE, Garcia-Ac A, Covarrubias-Herrera R. 2001. Trace-level determination of benzidine and 3,3'-dichlorobenzidine in aqueous environmental samples by online solid-phase extraction and liquid chromatography with electrochemical detection. *J Chromatogr Sci* 39(7):301-307. <http://doi.org/10.1093/chromsci/39.7.301>.
- Vithayathil AJ, McClure C, Myers JW. 1983. *Salmonella*/microsome multiple indicator mutagenicity test. *Mutat Res* 121(1):33-37. [http://doi.org/10.1016/0165-7992\(83\)90083-0](http://doi.org/10.1016/0165-7992(83)90083-0).
- Wang L, Yan J, Hardy W, et al. 2005. Light-induced mutagenicity in *Salmonella* TA102 and genotoxicity/cytotoxicity in human T-cells by 3,3'-dichlorobenzidine: a chemical used in the manufacture of dyes and pigments and in tattoo inks. *Toxicology* 207(3):411-418. <http://doi.org/10.1016/j.tox.2004.10.010>.
- WHO. 1998. 3,3'-Dichlorobenzidine. Geneva, Switzerland: World Health Organization. <https://www.who.int/ipcs/publications/cicad/en/cicad02.pdf?ua=1>. December 15, 2021.
- WHO. 2010. Guidelines for indoor air quality: Selected pollutants. World Health Organization. [http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0009/128169/e94535.pdf](http://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf). April 25, 2012.
- WHO. 2017. Guidelines for drinking-water quality. Fourth edition incorporating the first addendum. World Health Organization. <http://apps.who.int/iris/bitstream/10665/254637/1/9789241549950-eng.pdf?ua=1>. February 28, 2017.
- Wu Y-C, Huang S-D. 1998. Cloud point preconcentration and liquid chromatographic determination of aromatic amines in dyestuffs. *Anal Chim Acta* 373(2-3):197-206. [http://doi.org/10.1016/s0003-2670\(98\)00393-6](http://doi.org/10.1016/s0003-2670(98)00393-6).
- Zwirner-Baier I, Neumann HG. 1994. Biomonitoring of aromatic amines. IV: Use of hemoglobin adducts to demonstrate the bioavailability of cleavage products from diarylide azo pigments in vivo. *Arch Toxicol* 68(1):8-14. <http://doi.org/10.1007/s002040050024>.
- Zwirner-Baier I, Neumann HG. 1998. Biomonitoring of aromatic amines V: Acetylation and deacetylation in the metabolic activation of aromatic amines as determined by haemoglobin binding. *Arch Toxicol* 72(8):499-504.