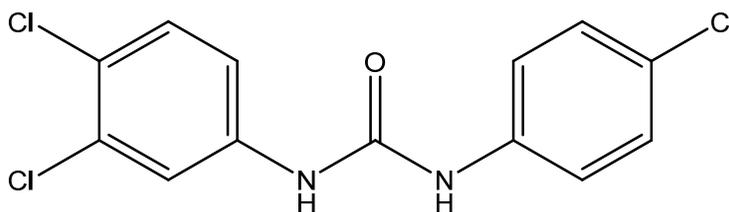


Triclocarban [CASRN 101-20-2]

(3,4,4'-Trichlorocarbanilide)

Potential Designated Chemical

May 24, 2010 Meeting of Scientific Guidance Panel (SGP)
Biomonitoring California¹



Exposure or potential exposure to the public or specific subgroups:

Triclocarban (TCC), or 3,4,4'-trichlorocarbanilide, is an antibacterial agent used in bar and liquid soaps and body washes. According to industry estimates, TCC may be added to bar and liquid soaps at levels ranging between 0.5 to 5% and to body washes at levels of 0.1 to 0.5% (TCC Consortium, 2002). Actual concentrations in bar soaps were expected to be limited to 1.5% (TCC Consortium, 2002). A study conducted in 1999-2000 found triclocarban in 84% of deodorant bar soaps sold in the United States (Perencevich et al., 2001). In 2002, the annual U.S. production/import volume of TCC was reported as 1-10 million pounds (U.S. EPA, 2002). U.S. EPA (2009) reported a production/import volume of less than 500,000 pounds in 2005, although this information was not found on the most recent Toxic Substances Control Act Inventory Update (U.S. EPA, 2006).

Recent studies report detection of TCC in surface waters and in sewage sludge (Heidler and Halden, 2009; Heidler et al., 2006; Halden and Paull, 2005; McClellan and Halden, 2010). One study assessing removal of organohalogens in 25 wastewater treatment facilities across 18 U.S. states (including California) found TCC in 100% of influent water, with a median concentration of 4.2 ± 0.8 ppb (range, 1.3-20.5 ppb). TCC was also found in 100% of effluent water, with a median concentration of 0.23 ppb (range: 0.011-1.78 ppb) (Heidler and Halden, 2009).

TCC that enters wastewater treatment plants is predominantly sequestered into sludge. The degree of degradation in sludge depends on the type of sludge treatment, with

¹ California Environmental Contaminant Biomonitoring Program, codified at Health and Safety Code section 105440 et seq.

greater degradation occurring under aerobic conditions compared to anaerobic conditions. Heidler and Halden (2009) reported TCC levels in the ppm range for both anaerobically digested sludge (median levels: 27.6 ± 7.2 ppm) and aerobically digested sludge (mean: 18 ppm). Consistent with these values, Snyder et al. (2010a) reported a mean TCC concentration of 19 ± 11 ppm in 23 biosolids samples from treatment plants across the U.S. that used different degradation processes. Approximately half of total biosolids generated in California and nationwide are applied to land as a source of crop nutrients. TCC has been found in soil following biosolids land application (Cha and Cupples, 2009). Information that OEHHA has gathered to date suggests that TCC mobility is limited, it has low potential for transport and predominantly remains sequestered in soil or biosolids (Snyder et al. 2010b; Al-Rajab et al., 2009; Edwards et al., 2009; Sabourin et al., 2009). OEHHA has not located any studies in the scientific literature that have investigated uptake of TCC by plants.

Early research in cultures of activated sludge showed that TCC decomposes to both p-chloroaniline and 3,4-dichloroaniline (3,4-DCA) (Gledhill, 1975). TCC is the suspected source of 3,4-DCA found in a U.S. Geological Survey study of contaminants in a wetland supplied with waste-water treatment effluent (Barber et al., 2006a,b; Halden, 2006). Commercial production of TCC uses either p-chloroaniline or 3,4-DCA in the starting material (TCC, 2002), so small amounts of these chemicals may be found in formulations and products that contain TCC. Chloroanilines may also be formed during storage and during soap manufacture (Eckard, 1984).

Known or suspected health effects:

The submission by the TCC Consortium (2002) to the U.S. EPA High Production Volume (HPV) Challenge Program summarized negative gene mutation and chromosomal aberration studies, a negative three generation reproductive toxicity study in rats, and a negative two-year cancer bioassay. OEHHA did not review the original studies.

OEHHA identified few toxicology studies related to TCC in the scientific literature. Two studies reported results from high-dose feeding experiments. Wright et al. (1975) reported that chronic feeding of TCC at 3,000 or 10,000 ppm in diet to rats for six months resulted in degeneration of the seminiferous tubules and oligospermia. No testicular lesions were seen at 1,000 ppm (100 mg/kg/day). These results were reported in a meeting abstract and details of the study were never published. Nolen and Dierckman (1979) fed groups of rats diets containing various percentages of a 2:1 mixture of TCC and 3-trifluoromethyl-4,4'-dichlorocarbanilide. In the group that was fed 0.25% of the mixture continuously through three pregnancies, the authors observed reductions in the number of animals that conceived, in the number of pups born to those that did conceive, and in the number of pups that survived until weaning.

Recently published *in vitro* studies suggest that TCC may amplify the actions of certain steroid hormones. Ahn et al. (2008) reported that TCC had little agonist activity for the estrogen (ER) or androgen (AR) receptor in reporter gene assays in recombinant ER or

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AR-responsive cells. However, in the presence of estrogen or testosterone, TCC enhanced the actions of these hormones. In another reporter gene assay, Chen et al. (2008) found that TCC did not compete with testosterone for binding to the AR or affect AR protein expression or AR-mediated signaling as did testosterone. However, in the presence of testosterone, TCC augmented testosterone's effects. Chen et al. (2008) also reported that male sex accessory organ weights were significantly increased in castrated male rats when the rats were simultaneously administered testosterone and exposed to TCC at a level of 0.25% in diet for 10 days. The effect was greater than when the rats were treated with either TCC or testosterone alone.

Giudice and Young (2010) have recently reported that TCC increased embryo production in the freshwater mudsnail *Potamopyrgus antipodarum*, in a manner similar to that seen after exposure to some known environmental estrogens. Whether the mechanism for these estrogenic effects is the same as that in the reporter gene assays referenced above is unknown.

Tanno et al. (2007) reported TCC-related cell damage and inhibition of DNA synthesis in immortalized rat hepatocytes. Zhao et al. (2006) observed TCC binding to the arylhydrocarbon receptor (AhR) and related inhibition of AhR-signaling, in reporter gene assays in recombinant cells from several species.

The Material Safety Data Sheet for TCC indicates that it is a chemical that may cause cancer and genetic damage (Sigma Aldrich, 2009). This designation may be in reference to the possible presence of p-chloroaniline, a Proposition 65 carcinogen.

Potential to biomonitor:

Physical and chemical properties

Property	Value
Molecular weight	315.59 g/mol
Vapor pressure	3.45 ×10 ⁻¹³ mm Hg at 25°C (experimental) ² 3.61 ×10 ⁻⁹ mm Hg at 25°C (estimated) ³
Water solubility	0.046±0.004 mg/L at 25°C (experimental) ¹ 0.11 mg/L at 20°C (experimental) ² 0.0237 mg/L at 25°C (estimated) ³
Octanol/water partition coefficient (Log K _{ow})	3.5±0.06 (experimental) ¹ 4.2 (experimental) ² 4.9 (estimated) ³

¹ Snyder et al. (2010a)

² TCC Consortium (2002)

³ Syracuse Research Corporation (SRC, 2009)

Persistence: In a 28 day biodegradability study, no TCC was degraded (TCC Consortium, 2002). The PBT Profiler (available at: <http://www.pbtprofiler.net/>) predicts a 120-day half-life in soil. Ying et al. (2007) found no degradation of TCC in anaerobic soil and a half-life of 108 days under aerobic conditions. These results are consistent

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with Wu et al. (2009), who estimated a half-life in soil of 87-231 days, depending on the type of soil and whether the soil was amended with biosolids. Snyder et al. (2010b) concluded that ultimate degradation of TCC in land-applied biosolids would require several years.

Bioaccumulation: A bioconcentration factor (BCF) of 137 was reported for TCC in catfish (TCC Consortium, 2002). Recent studies reported bioaccumulation of TCC in algae and two freshwater invertebrates (Higgins et al., 2009; Coogan and Point, 2008; Coogan et al., 2007). No studies were identified that investigated the potential bioaccumulation in terrestrial organisms.

Pharmacokinetics and metabolism: Scharpf et al. (1975) found minimal percutaneous absorption of TCC after six adult male subjects showered with bar soap containing TCC. In that study, 0.39% of an applied dose was identified in urine and feces after two days. North-Root et al. (1984) reported that after rinsing off TCC bar soap, a small amount of the applied TCC (1.4%) remained on the skin (n = 12). In a study where TCC was applied directly to the skin (site not specified) and not rinsed, Wester et al. (1985) estimated percutaneous absorption in five human subjects to be $7.0 \pm 2.8\%$ after urine was collected for 10 days. In an *in vitro* human skin model, Marty and Wepierre (1979; as cited and described by Scientific Committee on Consumer Products, 2005) found that the absorption of TCC through artificially compromised skin was approximately twice as great as in normal skin. Percutaneous absorption of TCC is also likely to vary with the anatomical site of application, as Maibach et al. (1971) showed in a study of pesticides.

Human metabolism of TCC involves direct glucuronidation to form N- and N'-glucuronides as well as ring hydroxylation to 2'-hydroxy-TCC and 6-hydroxy-TCC, which are further metabolized to sulfate and glucuronide conjugates (Hiles and Birch, 1978). In human subjects given a single oral dose of TCC, Hiles and Birch (1978) found that 27% of the dose was excreted in the urine within 80 hours; 70% was excreted in the feces within 5 days.

Past biomonitoring studies: Gruenke et al. (1987) identified TCC metabolites in plasma and urine in subjects who showered with TCC-containing bar soap. The major urinary metabolites were N-glucuronides (average levels, 30 ng/mL) and a major plasma metabolite was the sulfate conjugate of 2'-OH-TCC (levels ranged from 0-20 ng/mL). No details on the number of individuals or the percent TCC in the soap were reported. Scharpf (1975), described above, reported that blood levels were below 10 ppb (their limit of detection) at all sampling times. TCC was included in a study investigating the presence of lipophilic compounds in breast milk samples (n=20), but was not detected in any of the samples (Ye et al., 2006).

Need to assess efficacy of public health actions:

TCC is a widely used antimicrobial in consumer products. It is persistent in the environment. Recent studies suggest that TCC could have endocrine disrupting effects.

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Biomonitoring TCC will help the State to assess the extent of exposure to California residents.

Availability of analytical methods: A laboratory method for urine and blood samples involving solid-phase extraction liquid chromatography and tandem mass spectrometry (LC-MS/MS) was recently described in an abstract (Schebb et al., 2010). The Program would need to develop its own analytical methods.

Availability of adequate biospecimens: Plasma or urine biospecimens.

Incremental analytical cost: Analysis could be bundled with triclosan and certain other environmental phenols.

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