A WEIGHT-OF-EVIDENCE APPROACH ON THE BIOACCUMULATION POTENTIAL OF TRICLOSAN IN FISH

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Abstract

The anti-microbial biocide Triclosan (TCS) is used in various consumer products to control the growth of bacteria which may affect human health. Trained domestic wastewater effluent can be considered the principle source of TCS to the environment (i.e. receiving water bodies). Although secondary wastewater treatment typically achieves removal rates of 95% or greater, traces of TCS may enter surface waters such as rivers and lakes. Based solely on its physical-chemical properties (e.g. logPow of 4.76 at pH 7), bioaccumulation in aquatic organisms cannot be ruled out. Several studies of bioaccumulation in fish have been conducted in the past. Two bioaccumulation studies are publicly available: one indicates a biocaccumulation factor (BCF) below 5000 and the other a BCF above 5000. Consequently, it has been suggested that these two results should lead to a regulatory finding that TCS exceeds the regulatory threshold (BCF >5000) for TCS to be considered to bioaccumulate in the environment. Both studies were conducted using methods appropriate at the time of their completion, however not acceptable today. An evaluation of the bioaccumulation potential of TCS should take into account additional data on absorption (uptake), distribution, metabolism and excretion (ADME) of TCS in fish, along with ADME data for rodents and humans. TCS is excreted (half-life < 1 day) from the fish body via both urine and feces at rates comparable to mammals. These findings are further supported by GLAS calculations, revealing a fish BCF value of 642 (log BCF 2.8) and a biotransformation half-life of 3.29 d (SRC BCFBAF v. 3.01, 20.02.2012). It can be concluded that TCS is not bioaccumulative in fish. Moreover, this weight of evidence evaluation clearly indicates that the fish BCF test is not an appropriate means of characterizing the bioaccumulation potential of TCS. As a results, there is no need for additional fish bioaccumulation testing.

Data included in the Weight-of-Evidence evaluation

a) Two fish bioaccumulation studies
b) Environmental monitoring data
c) Unpublished data on absorption (uptake), distribution, metabolism and excretion (ADME) of TCS in fish
d) Data on bioaccumulation of TCS in mammalian species such as rodents, dogs and humans

Results

a) Fish BCF Studies

i) Orres et al. 2002

- Average BCF: 3407 (4281 and 2532 at 3 and 30 pg/g TCS, respectively); Depuration half-life: 97% within 1 week
- Deficiencies: Values are not lipid normalised
- Preliminary conclusion: TCS does not exceed the regulatory threshold for bioaccumulation in fish

ii) Schettgen et al. 1999

- Average BCF: 8150 ± 1447 at pH 7 (7070 ± 8700 in the range of pH 6 – 9, at 35 = 50 µg/g TCS); Depuration half-life: 16.8 h
- Deficiencies: Analytical recovery of 150%; high concentration of solvent used; test concentrations >1/100 of LC50 value
- Preliminary conclusion: TCS exceeds the regulatory threshold for bioaccumulation in fish

b) Environmental monitoring

i) Fish monitoring study in Sweden (Adolfsson-Erici et al. 2002)

- Caged trout showed highest TCS bile concentrations for STP effluent exposure compared to further downstream (47 mg/kg vs. 17 mg/kg)
- Wild trout had lower concentrations than caged trout (trout 2 km DS: 17 mg/kg; roach 2.5 km DS: 4.4 mg/kg; roach at other sites < 1 mg/kg)
- Uptake at high concentration exposures; Rapid depuration via the kidney
- Wild fish had lower concentrations due to lower exposure; natural migration decreased continuous high level exposure

ii) German specimen database (Rüdel et al. 2013)

- TCS in fish (fresh: TCS was measured from 1994 to 2003 and 2008 at 16 sites)
  o TCS concentrations in muscle tissues showed no evidence of increase over the past years
  o Suspended matter (SMP: TCS was measured 2005 to 2007)
  o TCS could not be detected in the SMP samples (≤0.3 ng/g 4d)
- No bioaccumulation of TCS observed in fish over the time

Discussion and Conclusions

- TCS should not be considered bioaccumulative in fish
- TCS is rapidly absorbed and eliminated (TCS is excited via both the feces (incl. bile fluids) and kidney waste)
- Environmental monitoring data shows no trend of increasing TCS concentrations in fish muscle tissue
- Based on the structure and chemistry of TCS and how it behaves in fish, the standard fish BCF study is not representative of the true BCF potential of TCS
- ADME is similar in rodents and mammals with no evidence of bioaccumulation
- These findings align with the outcomes from the recent SETAC Pesticide Workshop on Science-Based Guidance and Framework for the Evaluation and Identification of PBTs and POPs (Gobas et al., 2009)
- Practices are currently evolving related to the framework for identifying bioaccumulative substances
- A ‘weight of evidence’ based approach towards assessing bioaccumulation potential of chemicals is needed
- Assessments of standard fish BCF data against arbitrary historical criteria, in isolation, may represent an overly simplistic approach towards the assessment of the bioaccumulation potential of a given substance

References