A critical review of prochloraz effects in fish

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The imidazole fungicide prochloraz is registered in the EU for use on various crops and is one of the most data-rich substances regarding chronic toxicity to fish. The aim of this literature review was to investigate the available literature for consistency in observed effects and mechanisms and for potential differences in sensitivity between fish species and to discuss the relevance of prochloraz exposure for fish populations in the field.

Available literature on the effects of prochloraz on fish was identified through Web of Science, regulatory data and OECD test guideline validation studies. Results from a total of over 50 *in vivo* experiments are included in this review. Endpoints of interest were apical effects (survival, growth, reproduction, development) as well as biomarkers. The dominant effect of prochloraz in fish seems to be the inhibition of aromatase (CYP19), an enzyme which catalyses the conversion of testosterone to 17β-estradiol. Inhibition of aromatase leads to a lack of 17β-estradiol and a surplus of testosterone, causing various effects in (female) fish, such as reduction of 17β-estradiol concentrations, reduction of vitellogenin or a shift in the sex ratio towards males.

The effects reported in the literature were consistent with the known modes of action and showed that prochloraz may affect the endocrine system of fish and cause effects on growth, with LOECs roughly ranging from 30 to 300 µg/L. Apart from a few exceptions, effects followed monotonic concentration-response curves. The sensitivity of different fish species and endpoints is quite comparable, except that medaka might be more sensitive regarding reproduction. Aquatic invertebrates and algae show a higher sensitivity to short-term exposures than fish.

Measured environmental concentrations of prochloraz in natural surface waters are about 1000 times below the median concentrations causing effects in laboratory tests with fish under continuous exposure. These data suggest that the exposure of prochloraz in the field is too low to cause effects in fish. This notion is supported by the fact that no effects related to prochloraz have been found in natural fish populations.