



Assessment of (anti-) oestrogenic and (anti-) androgenic activities of final effluents from sewage treatment works

Science Summary SC020118/SS

In March 2002, the Environment Agency committed itself to furthering the risk assessment and risk management of oestrogenically active effluents. The purpose of this project was to provide information on the (anti-) oestrogenic and (anti-) androgenic profile and activity of 43 sewage treatment works effluents. The data collated in this study was used in a separate risk assessment of the impacts of steroid discharges, which influenced site selection for an 'endocrine disruption demonstration programme'. The demonstration programme will evaluate the efficacy of existing and improved treatment processes at reducing steroid concentrations and endocrine disrupting effects in effluents.

Main findings of this study:

- One, two or all three steroid oestrogens (oestrone, oestradiol and ethinyloestradiol) were measured at most sites, with concentrations in the ranges of <1 to 100 ng l⁻¹ for oestrone, <1 to 22 ng l⁻¹ for oestradiol and <1 to 3.2 ng l⁻¹ for ethinyloestradiol.
- There were high levels of steroids, primarily oestrone, in final effluents from a number of locations. We found oestrone concentrations of ≥ 20 ng l⁻¹ in 21 of the 43 effluents.
- A risk assessment of the effluents, taking into account data on effluent flow, steroid loads and river dilution is presented in a separate risk assessment report. However, a basic comparison of the steroid concentrations found with the proposed Predicted No Effect Concentrations (PNECs) for steroids indicates that a number of effluent discharges, even following dilution, would result in receiving water steroid concentrations that could result in oestrogenic effects in fish downstream of the discharges.
- Levels of nonylphenol in final effluent samples ranged from <1 to 7.7 µg l⁻¹. The majority of effluent concentrations were in the range of <1 to 3 µg l⁻¹. Concentrations of > 3 µg l⁻¹ were measured at only eight of the 43 sites sampled.
- These results suggest that nonylphenol (at least in isolation) is less likely to elicit oestrogenic responses in fish downstream, once dilution of the effluents is taken into account at the majority of sites.
- Lower chain nonylphenol ethoxylates were also measured in the effluents at varying concentrations. The available data indicate that the oestrogenicity of nonylphenol ethoxylates decreases with increasing chain length, although limited data are available on the relative potencies of the lower chain ethoxylates. However, the use of nonylphenol ethoxylates was restricted from January 2005, so their contribution to oestrogenic effects in the environment is expected to diminish.
- All of the samples tested exhibited some *in vitro* oestrogenic activity in the Yeast Oestrogen Screen (YES assay), with oestradiol potency equivalents of between 0.4 and 42.7 ng l⁻¹.
- None of the samples tested exhibited any clear anti-oestrogenic activity.
- Only final effluents from one location were found to contain any detectable androgenic activity.
- All samples, though, exhibited significant anti-androgenic activity, with flutamide potency equivalents of between 21.3 to 1231 µg l⁻¹.
- The substances for the anti-androgenic activity are unknown. Anti-androgenic substances, though, suppress the effects of androgens in male fish and could contribute to a feminising effect. The wider biological significance of the anti-androgenic activity (notably in the generation of intersex) are not known. Defra are currently funding a project to determine the biological significance of androgen antagonism as part of their research programme on endocrine disruption in the aquatic environment (EDAQ).
- The detection of anti-androgenic effects at this stage does not detract from the focus of removing

steroid oestrogens from effluents in the proposed demonstration programme. It suggests, though, that anti-androgenic biological effects should also be taken into consideration when monitoring treatment options during the demonstration programme.

This report will be of interest to scientists working in the field of endocrine disruption. It will also be of interest to the water industry and is relevant to policy makers in the UK, who are assessing risks from oestrogenically active effluents.

The data generated in this study were used in a risk assessment of the impacts of steroid discharges and influenced site selection for the endocrine disruption demonstration programme. The demonstration programme will deliver a sound understanding of treatment efficacy, costs and benefits of risk management options for reducing impacts of steroid discharges into the aquatic environment. It will therefore influence the shape of future investment in sewage effluent treatment in further water industry periodic review programmes and the scale of that investment across England and Wales.

This Summary relates to information from Science Project SC020118/SR reported in detail in the following output:-

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