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Ecotoxicological evaluation of the effects caused by transformation products and byproducts from chemical treatment

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Introduction

Chemical oxidation treatment is an effective, innovative technology in wastewater treatment plants for removal of micro-pollutants in the effluent. In particular, ozonation (O_3) and chlorine dioxide (ClO_2) treatments are commonly used to degrade organic pollutants. By oxidation, the micro-pollutants are generally transformed to compounds that are easier to degrade biologically. There is, however, a risk that the transformation products will have structures similar to the parent compound and still be biologically active. These metabolites can then still be toxic to non-target organisms and have the same, or greater, effects in the recipient.

The **aim** of this study is to evaluate the potential risk of oxidation treatment, using O_3 and ClO_2, due to formation of toxic transformation products.

Method

Treated waste water (WW) and a mixture of 114 pharmaceuticals (API) was treated with O_3 and ClO_2. Acute test with *Daphnia magna* and *Pseudokirchneriella subcapitata* was conducted on these water according to OECD standards.
The initial API concentration in the spiked water corresponded to EC_{50}/LC_{50} of the mixture.
In some experiments Na_2SO_3 was added after one hour of oxidation to eliminate excess ClO_2/O_3 before start of toxicity tests, while in other experiments toxicity tests were done at 24 h treatment.

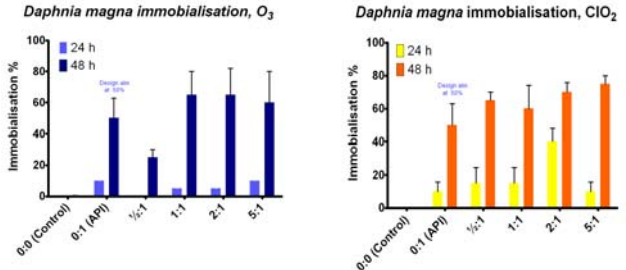
Discussion

The biological tests with *D. magna* did not show any effects on the toxicity due to reduction of pharmaceuticals or generation of metabolites. There was decrease in toxicity observed for *P.subcapitata* in the API-water treated with low doses of ClO_2. This could be a result of increased reduction of the pharmaceuticals in the API mix. The reduction potential of pharmaceuticals by the two oxidation mediums are similar. However, oxidation with ClO_2 requires additional treatment to reduce the toxicity. The growth inhibition of algae in O_3-treated WW decreased when it was left to oxidize for 24h, which indicates elimination of residual O_3 during time.
Oxidation of WW is an efficient method for elimination of pharmaceuticals even though it had little or no effects on the acute toxicity.

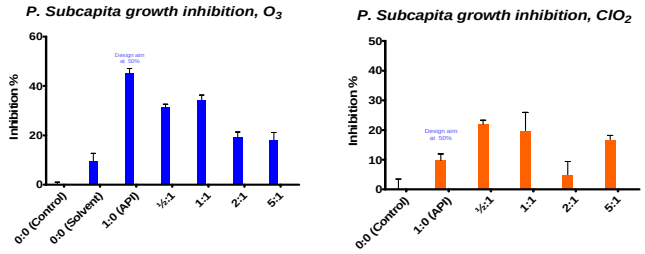
Conclusions

Ozone treatment reduced toxicity of the pharmaceuticals mixture to alga, but had no effect on the Daphnia toxicity or the toxicity to both species in wastewater effluent.
ClO_2 increased the toxicity in most experiments, but this may be due to chlorite residuals rather than toxic degradation products.

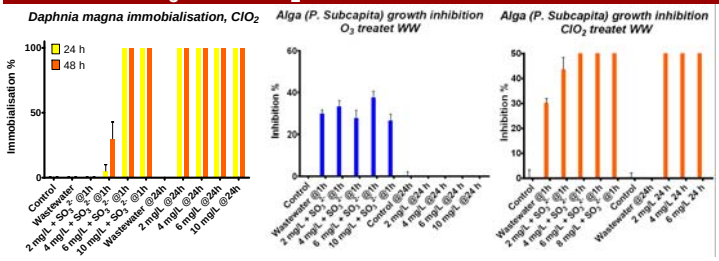
O_3 and ClO_2 results on mixture of pharmaceuticals



Treatment of water spiked with 114 pharmaceuticals with ozone did not change the toxicity to *Daphnia*, but a dose dependant trend for reduced toxicity was seen in the alga toxicity.
ClO_2 did not as change the toxicity to alga, but a trend for increased *Daphnia* toxicity is seen after 48 h exposure.



O_3 and ClO_2 results on wastewater



O_3 treated WW was not toxic to *Daphnia* with any ozone treatment (not shown). The toxicity of WW to alga did not change in the 1h experiment with dose. In the 24h treatment the alga control growth was lower than all test concentration, which makes the results unreliable.
ClO_2 did not change toxicity at 2 mg/L, but at 4 mg/L and higher significant toxicity was seen to both alga and *Daphnia*. Chlorite risiduals (ClO_2^-) is suspected to be responsible, since control treatment with sulphite was not always able to remove toxicity of pure ClO_2.

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