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Science for Environment Policy

UV water treatment may increase antimicrobial activity of linezolid antibiotic

UV treatment does not always turn hazardous water pollutants into harmless substances. Recent lab tests suggest that the toxicity of the antibiotic linezolid to microorganisms appeared to increase post-treatment. This research did find, however, that UV treatment successfully reduced the antimicrobial activity of four other antibiotics tested, plus four artificial sweeteners.

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The potential ecological impacts of antibiotics and artificial sweeteners are attracting the attention of environmental scientists. Antibiotics can continue harming bacteria once in the environment, and there is also concern about the widespread presence of artificial sweeteners in groundwater and seawater. Sweeteners pass through the human body largely unchanged and enter the environment via domestic wastewater. They are tested for antimicrobial activity before consumer use, but little is known about their long-term environmental effects.

This German study investigated the persistence and antimicrobial activity of five antibiotics (levofloxacin, lincomycin, linezolid, marbofloxacin and sarafloxacin) and four artificial sweeteners (acesulfame, cyclamate, saccharine and sucralose) in the environment.

In particular, they looked at the impact of water treatment on these substances. It is well known that treatment methods based on 'advanced oxidation processes', such as UV irradiation, are often effective at degrading target chemicals, but may not break them down completely. Instead, new 'transformation products' may form during breakdown that can be even more persistent or toxic than the original substance.

Laboratory tests revealed that only the sweeteners cyclamate and saccharine could be considered biodegradable, over 28 days of study. The researchers suggest all the other substances are likely to persist in the environment in their original form, unless they have been removed via treatment. Furthermore, despite the biodegradability of cyclamate and saccharine, the researchers note that these sweeteners are widely found in the environment because such large quantities are released.

They then re-created UV-treatment conditions using a mercury lamp. Most substances were either completely or near-completely removed within 128 minutes of treatment. Exceptions were cyclamate, lincomycin and sucralose; concentrations of these fell but by a relatively small amount.

Further tests detected transformation products in treated water for four of the antibiotics (linezolid, levofloxacin, marbofloxacin and sarafloxacin) and one of the sweeteners (acesulfame). These were all products that had been degraded by UV treatment.

To assess the potential toxicity of the UV-treated and non-treated samples of water to wildlife, they applied them to two bacteria: *Pseudomonas putida* and *Vibrio fischeri*. UV treatment appeared to be a promising water-purification technique for three of the antibiotics, marbofloxacin, levofloxacin and sarafloxacin, as treated samples were much less toxic than untreated samples, as judged by their effects on the growth of *P. putida*. However, linezolid samples increased in antimicrobial activity after their UV treatment, due to the presence of the transformation products.

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Sweeteners inhibited growth of *P. putida* to a small degree, but treatment did not reduce or enhance this effect.

No substances appeared to be toxic to *V. fischeri,* either pre- or post-treatment. In addition, no toxic effects for humans were observed in this study, based on tests on cells and DNA.

The researchers conclude that UV treatment may help tackle the problem of bacterial resistance to antibiotics as it reduced the toxicity of several pharmaceuticals tested here. However, the linezolid results also led them to conclude that UV treatment may not be a large-scale effluent treatment option for linezolid, and they raise concerns about toxic transformation products accumulating in the environment.

At present, linezolid is not widely used and environmental levels are likely to be low. However, the researchers caution that prescription rates may rise in future because bacterial resistance to another antibiotic, vancomycin, is increasing.