Bacteria convert wastewater chemicals into toxic form

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(PhysOrg.com) -- While traces of pharmaceutical compounds are commonly present in wastewater, interactions with bacteria during the treatment process could transform them from non-toxic to toxic forms, a new study suggests.

Some drugs can occur in two forms, known as enantiomers. While they are chemically very similar, pairs of enantiomers can have drastically different effects on the human body, ranging from medically beneficial to highly toxic.

In cases where both parts are known to be safe, drugs are manufactured and dispensed as mixtures of the two forms. However some drugs are dispensed as single enantiomers since the other form is known to be toxic.

In a study published this month in the journal Water Research, UNSW researchers monitored three common pharmaceuticals during wastewater treatment. These included the anti-inflammatory drug naproxen, which is manufactured and dispensed as a single enantiomer, known as S-naproxen. Its counterpart, R-naproxen, is known to be highly toxic to the liver and is not publicly available.

Through the treatment process, researchers observed that some of the safe version of naproxen had been converted to the unsafe form, which could have negative environmental implications. It is the first time that enantiomeric inversion during the wastewater treatment process has been reported.

“We found that some of the S-naproxen had turned into R-naproxen, so even though we’re measuring a major reduction in the concentration of naproxen, the overall toxicity could be increasing,” says study supervisor Dr. Stuart Khan, an environmental engineer at the UNSW Water Research Center.

The process mimics a similar transformation that can be seen in the human gut, where drugs believed to be safe can be inverted during metabolism into their toxic forms.

The most famous case of such inversion is that of thalidomide, a drug designed to control morning sickness that was administered to pregnant women in the late 1950s. Although manufactured as a pure enantiomer, it underwent unexpected inversion in the human gut and caused horrendous birth defects.

Many international studies have reported on the effectiveness of wastewater treatment processes for removing various pharmaceuticals, however, the vast majority of these studies use analytical methods that don't differentiate between the two enantiomers.

Khan says current eco-toxicological assessments will not be looking for the toxic version of naproxen because it's not a registered pharmaceutical, so it may not turn up on lists of chemicals requiring assessment.

As a result, assessment will need to be refined and optimised. "We can't just look at what's disappearing during the wastewater treatment process, but we need to consider what it's turning into," he says. "And is this breakdown product an even greater concern than the original compound?"

It's not well understood how this transformation is occurring in wastewater, but is believed to be enzyme-driven, says Khan, and is being caused by microorganisms in the treatment plant converting the non-toxic form into the toxic form.

Khan and his colleagues are now working to better understand the mechanism of the inversion process and identify other pharmaceuticals for which similar changes may be occurring during wastewater treatment.

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