Steroids may persist longer in the environment than expected

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Agricultural runoff, including trace amounts of organic contaminants, can drain from cattle grazing areas into nearby aquatic systems like this stream. Credit: Edward P. Kolodziej

Assessing the risk posed to aquatic organisms by the discharge of certain steroids and pharmaceutical products into waterways is often based on a belief that as the compounds degrade, the ecological risks naturally

decline.

But there's growing sentiment that once in the environment, some of these bioactive organic compounds may transform in a way that makes their presumed impact less certain.

A new study led by the University of Iowa and published online Thursday in the journal *Science* found this was the case with the anabolic steroid trenbolone acetate and two other drugs.

Once popular in the bodybuilding and weightlifting communities,trenbolone acetate is now banned for human use. However, it is federally approved for use by the beef industry to promote weight gain and increase feeding efficiency in cattle.

In lab tests followed by field experiments, the researchers found that trenbolone does not fully break down in water as believed, retaining enough of a chemical residue to regenerate itself in the environment under certain conditions, to an extent that the drugs' lives may be prolonged, even in trace amounts.

Researchers says the study is a first step toward better understanding the environmental role and impact of steroids and pharmaceutical products, all of which have been approved by the federal government for various uses and that have been shown to improve food availability, environmental sustainability and human health.

"We're finding a chemical that is broadly utilized, to behave in a way that is different from all our existing regulatory and risk-assessment paradigms," says David Cwiertny, assistant professor in engineering at the University of Iowa and a co-corresponding author on the paper."What our work hopefully will do is help us better understand and assess the environmental fate of emerging contaminant classes. There are

a variety of bioactive pharmaceuticals and personal-care products that we know are present in trace amounts in our water supply. We should use what we're learning about trenbolone to more closely scrutinize the fate and better mitigate the impact of these products in the environment."

The team found similar results for dienogest, a hormone used in a birth-control pill called Natazia, and dienedone, a banned anabolic steroid that has been marketed as a body-building supplement.

Trenbolone acetate is implanted in the ears of more than 20 million cattle in the United States, according to studies cited by the researchers in their paper.

The drug is metabolized and then excreted by livestock, and makes its way into waterways mainly through runoff.

The steroid has been considered safe due to its rapid degradation, with studies pointing to an environmental half-life of less than a day. But there has been concern that it and other synthetic drugs, when found in concentrated amounts, can be harmful to aquatic species and the environment generally. Studies have pointed to steroids and other drugs' effects on fish, through fewer eggs produced by females to skewing the sex of some species.

"We rarely see fish kills anymore, and we probably aren't discharging many carcinogens into surface waters anymore. But I don't believe this necessarily means that our water is safe for aquatic organisms," says Edward Kolodziej, associate professor in engineering at the University of Nevada-Reno and the other corresponding author on the *Science* paper. "It just might be harder to characterize the adverse effects associated with contaminant exposures these days."

Sunlight is one catalyst for breaking down compounds in the environment. But in this study, by simulating day and night in the lab, the research team found that the steroid's chemical compounds never fully disappeared in daylight. Moreover, during a simulated night, under typical surface water conditions, some of the compounds regenerated themselves, to as much as 60 percent of the metabolite's initial mass, when tracked over a 120-hour period.

"We knew something unique was going on," Cwiertny says. "In daylight, it essentially hides in another form, to evade analysis and detection, and then at nighttime it readily grows back."

More of the drug's mass was regenerated – up to 88 percent in one highly acidic state (pH 2) – when water temperature was higher and when it was more acidic or alkaline, the team found.

The researchers validated the lab results with two experiments in the field – one with water culled from the Iowa River in Iowa City, Iowa and the other from samples taken from a collection pond at a cattle rangeland and research operation run by the University of California.

More information: "Product-to-Parent Reversion of Trenbolone: Unrecognized Risks for Endocrine Disruption," by S. Qu et al. *Science*, 2013.

Provided by University of Iowa