Inactive components in agricultural runoff may be hidden contributors to drinking water hazards

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Inactive ingredients in agricultural, pharmaceutical, and other common products have typically been excluded from consideration as potential

contaminants in drinking water. However, while these chemicals are inert in certain products, they can still pose hazards when combined with other materials during the drinking water treatment process.

A new study from researchers in the McKelvey School of Engineering at Washington University in St. Louis reveals how large this impact might be. Jean Brownell, a graduate student working with Kimberly Parker, associate professor of energy, environmental & chemical engineering, led the investigation. Brownell examined the use of amines in herbicides and their potential role as precursors to nitrosamines, harmful byproducts formed during water disinfection.

Brownell discovered that inactive amines, which are used as stabilizing agents in herbicides to increase solubility and reduce drift, may be more important than active agents in herbicides when it comes to forming disinfection byproducts (DBPs) linked to various health risks, though the impacts vary by region and time. The results were published in the April 15 issue of *Water Research*.

"Everybody needs healthy food to eat and clean water to drink, so there's clear motivation for us to look at how herbicides used in agriculture impact water treatment downstream," Brownell said.

"We need herbicides to support effective modern farming, but we also need to examine our assumptions about these products to make sure we haven't missed side effects that might pose risks to people's health and safety. That's why we're analyzing trends in herbicide use that have changed over the past 20 years but have not been reevaluated in terms of how those changes also impact chemical precursors of DBPs."

Brownell compared the annual use of amines in herbicides to other known nitrosamine precursors, such as the widely used pharmaceuticals ranitidine and metformin. She found that the use of amines in herbicide

formulations has increased in recent decades, particularly affecting certain regions including the Midwest.

Because of the quantity of amines used, Brownell found that these inactive agents are potentially much more important nitrosamine precursors than researchers previously thought. Amines from herbicides have the potential to enter the environment at rates similar to precursors from pharmaceuticals. This could have significant implications for water treatment processes, as nitrosamines are known to pose serious health risks even at low concentrations.

"We always want to know what the precursors are and where they come from," Parker said. "The conventional wisdom was that the main source of nitrosamine precursors was consumer products—things like pharmaceuticals, fabric dyes, and so on—that enter the environment via municipal wastewater, and agricultural runoff wasn't a big source.

"But when agrochemical practices change, we can't keep applying old results. We need to evolve our studies and question our assumptions to make sure what we're assuming is either truly generalizable or alternatively, needs to be appropriately applied to local areas."

Brownell's analysis confirms that shifting trends in herbicide formulation and use necessitate a closer look at nitrosamine precursors. These studies need to be done at specific locations and times of year to account for variations across space and time, which Brownell found could be large and impactful. Brownell and Parker also highlighted the importance of collecting and sharing high-quality data from farmers and agencies across regions to support consistent best practices for water and food safety.

"This paper raises questions that require more work to find answers," Parker noted. "We do need to rethink our assumptions that led us to

think agriculture is unimportant for nitrosamine precursors, but this needs to be followed up with field research to test and verify these findings."

More information: Jean M. Brownell et al, Making Waves: Formulation components used in agriculture may serve as important precursors for nitrogenous disinfection byproducts, *Water Research* (2025). DOI: 10.1016/j.watres.2025.123116