Artificial sweetener as a wastewater tracer

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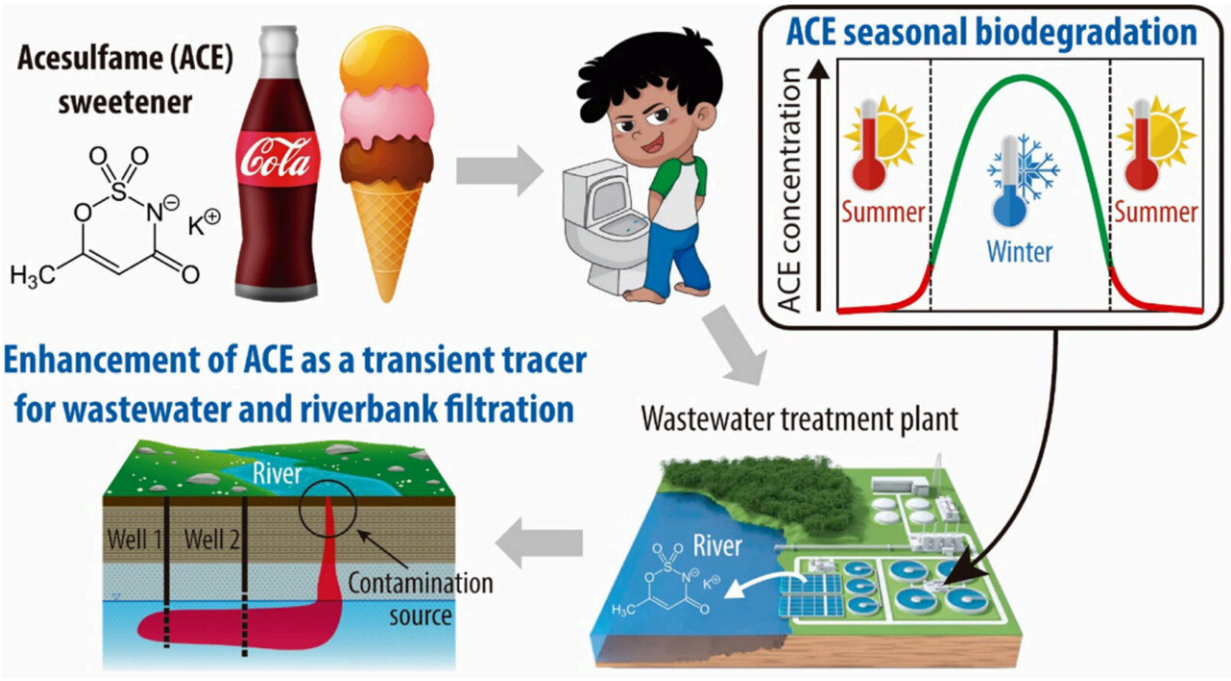

Graphical abstract. Credit: *Water Research* (2023). DOI: 10.1016/j.watres.2023.119670

Acesulfame is a sweetener in sugar-free drinks and foods. As it cannot be metabolized in the human body, the sweetener ends up in wastewater after consumption and remains largely intact even in sewage treatment plants. A new study by the University of Vienna shows that the persistence of the sweetener varies with temperature as the concentration of the sweetener in wastewater varies with the seasons.

The environmental geosciences team analyzed how groundwater flows can be traced based on these seasonal fluctuations. Since residues of the sweetener end up in drinking water, acesulfame serves as an indicator of the origin and composition of our drinking water. The study has now been published in the journal *Water Research*.

The sugar substitute acesulfame is one of the most commonly used sweeteners in Europe. It is almost 200 times sweeter than sugar and temperature-stable, making it suitable for sugar-free baking and for sweetening most diet lemonades. Because the human body does not metabolize the substance, it ends up in wastewater when consumed in large quantities and remains there even after treatment, but in fluctuating concentrations.

The new study by the University of Vienna shows that the substance is broken down to varying degrees over the year depending on the temperature. "For a long time, it was assumed that the potassium salt of acesulfame is not degraded at all in wastewater treatment plants. This is still true, but only in the cold season," explains Thilo Hofmann, deputy head of the Centre for Microbiology and Environmental Systems Science at the University of Vienna.

"There were already initial indications that at least partial biodegradation takes place in summer. We can prove this in our study and systematically show for a longer period of time how the concentration of the sweetener in the water changes with the seasons."

Sweetener acesulfame: Indicator for the flow paths of wastewater treated in sewage treatment plants

Acesulfame is a widely used indicator of wastewater discharges into surface waters and groundwater: since this sweetener is not completely

degraded both in wastewater treatment plants and in the environment—after it has been discharged into water bodies with the treated wastewater—a detection of the substance in water indicates that and how much treated wastewater has entered groundwater, rivers or lakes.

"If you follow the traces of the substance, you can ultimately trace flow paths of the wastewater and its mixing with groundwater," Hofmann explains. With the knowledge of seasonal fluctuations in the degradation of the substance, acesulfame becomes an even more meaningful tracer.

Computer models of groundwater flows enable risk prevention

"Our study shows that the seasonally fluctuating concentration of acesulfame can be used to better visualize and understand the processes in the subsurface, i.e. groundwater flows," says Hofmann. Wastewater components in drinking water can be recorded as well as the flow velocity of the groundwater and the mixing ratios of groundwater and river water.

The environmental geoscientists evaluated river and groundwater samples that were collected regularly over eight years in a pre-alpine catchment. The research team linked their analyses to computer models that calculate water flows in the subsurface. "Such computer models are the key to risk prevention, because they can be used to understand how much river water and how much groundwater end up in the population's drinking water and how to optimize the operation of waterworks," adds the head of the research group.

Traces of the sweetener end up in drinking water

The sweetener acesulfame thus lays a tracer trail from wastewater to river and groundwater and finally to our drinking water. "The fact that acesulfame is not degraded is basically a good thing for us hydrogeologists, because we can draw valuable information from it," says Hofmann.

He adds, "However, this fact also makes us aware of our lifestyle being reflected in the wastewater and thus also in the drinking water: The sugar substitute we consume ends up back in our drinking water—albeit heavily diluted, of course."

More information: Miguel Angel Marazuela et al, Seasonal biodegradation of the artificial sweetener acesulfame enhances its use as a transient wastewater tracer, *Water Research* (2023). DOI: 10.1016/j.watres.2023.119670

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