Artificial sweetener leaves lingering aftertaste in the environment

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(PhysOrg.com) -- Recently, the global use of artificial sweeteners in foods has dramatically increased. A new study led by Cesar Torres, and Rosa Krajmalnik-Brown – researchers at the Biodesign Institute at Arizona State University – examines the trail of sucralose, one of the most popular of such products, after it is digested in the human body.

ASU researchers, along with their collaborators, report in a recent issue of the journal *Environmental Engineering Science*, that sucralose is remarkably resistant to breakdown processes common in wastewater treatment plants, ultimately finding its way into ground and surface waters.

The full effects of growing quantities of sucralose in the environment are presently unknown. "Sucralose is a chlorinated sugar. Some of my work focuses on bioremediation of chlorinated organics," says Krajmalnik-Brown. "I know that many are toxic and they are more difficult to biodegrade than the non-chlorinated counterparts. Because of this, I became interested in sucralose and its fate in the environment."

The initial experimental work was performed by Smitha Ramakrishna, who at the time was a high school intern at the Biodesign Institute. For her innovative research, she received multiple awards including the Arizona Governor's Future Innovator Award (2008), and the Stockholm Junior Water Prize Regional Winner (2008). She continues her studies in the field at the Department of Environmental Science and Public Policy at Harvard College, Harvard University.

Artificial sweeteners appear in a dizzying assortment of consumer products. Sucralose – a chlorinated carbohydrate popularly marketed under the brand name Splenda® – iis one of the most ubiquitous, appearing in over 4000 products sold in over 80 countries. Its widespread adoption followed approval by the U.S. Food and Drug Administration in 1999. Launches of new products containing the sweetener increased by 15 percent in 2009 and total worldwide sales increased by 14 percent in 2010.

Sucralose and other artificial sweeteners are used for a variety of reasons, most commonly as low calorie weight-loss alternatives to sugar and for those suffering from glucose-related ailments like diabetes. Prior studies have indicated that sucralose is not broken down by the human body, but passes instead through the digestive tract to be expelled in feces and urine.

While some studies suggest that sucralose has very low toxicity, making it safe for human consumption, it has recently been shown in animal models to have measurable impact on the chemical and microbiological condition of gut microflora. The full implications of these changes and their relevance to human consumption of sucralose have yet to be properly investigated.

What is currently known, is that essentially all of the sucralose consumed in foods ultimately winds up in wastewater treatment plants. Here, domestic and industrial sewage will undergo several stages of treatment, designed to degrade or remove harmful elements, before they are expelled into natural waterways. Such treatment plants use a combination of physical, chemical and biological processes to treat wastewater and remove potentially harmful organic substances.

The molecular structure of sucralose is hydrophilic, meaning that it is highly soluble in water and unlikely to settle out of solution. For this reason, chemical processes (including disinfection) or biological processes (either anaerobic or aerobic degradation) offer the only alternatives. The new study however, shows that these processes are similarly ineffective in degrading sucralose in wastewater treatment facilities.

The effectiveness of anaerobic and aerobic treatment of sucralose was evaluated through the field sampling of wastewater and surface water. The aim of the study was to identify what elements in the treatment process could be manipulated to successfully degrade sucralose, prior to its entry into the environment.

Sampling of wastewater was carried out at seven full-scale wastewater treatment plants in southern Arizona. Lab-scale anaerobic and aerobic biodegradation of sucralose was examined in biological batch reactors, which ran for at least 48 days. The results of the wastewater sampling showed that at each of the seven treatment facilities, no correlation could be detected between the level of treatment and sucralose concentration, indicating that sucralose was highly resistant to all forms of degradation.

In the batch reactors, degradation of wastewater sludge was examined under three experimental conditions, using sucrose, sucralose, and a combination of the two. None of the experimental conditions yielded significant sucralose degradation. The group also examined one of the final stages of conventional wastewater treatment, in which chlorine, O3 or UV light are used to disinfect and degrade those compounds resistant to other means of breakdown. In all three cases, degradation of sucralose was found to be negligible.

The authors stress that the resistance of sucralose to degradation may have a positive side, in that intermediary chlorinated products, which may be highly toxic to humans are not produced. Further, the resiliency of sucralose may make it useful to environmental engineers as a labeling agent to trace wastewater contributions to the environment.

The study showed that successful breakdown of sucralose would require additional interventions above and beyond conventional wastewater treatment, for example the use of filtration through activated carbon, which has been shown in other studies to enhance sucralose removal. In the meantime, the study establishes that sucralose is able to endure existing treatment and to travel significant distances from its point of discharge. With sucralose production and use increasing at such a rapid clip, it is of vital concern that long-term environmental impacts to plant and animal species as well as to humans be addressed.

Provided by Arizona State University

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