Shedding light on potential toxins that lurk in blood and breast milk

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UB chemistry professor Diana Aga, left, and chemistry doctoral candidate Deena Butryn examine blood and breast milk samples using the one-shot method. Credit: Douglas Levere

Toxic flame retardants used in electronics and fabrics have been banned or removed from American and European products for nearly a decade. Yet they still surround us – in the dust we breathe and the food we eat. The chemicals are even found in the breast milk of new moms.

Researchers struggle to detect these compounds and the products they break down into inside the human body because current testing methods

often are inefficient or expensive to conduct on a large scale.

However, a new method – dubbed the "one-shot" analysis – has streamlined the process, allowing researchers to analyze brominated flame retardants and their breakdown products at once, shortening two weeks worth of testing to a few days.

Developed by University at Buffalo professors Diana Aga and James Olson, the new technique could enable scientists to provide a more complete picture of how the toxins accumulate in our bodies. Past studies examined these flame retardants but not their breakdown products, which can also be toxic.

Portions of the research, funded by the National Institute of Environmental Health Sciences, were published in several journals this year, including *Analytical Chemistry*, *Chemical Research in Toxicology* and, most recently, in *Analytica Chimica Acta* on Aug. 26.

Flame retardants: An unknown health risk

The study examined one class of brominated flame retardants, polybrominated diphenyl ethers (BDE), and its hydroxylated (OH-BDE) and methoxylated (MeO-BDE) breakdown products.

Brominated flame retardants are man-made chemicals that halt or slow the spread and duration of fires, but also have been linked to delayed brain development in children, negative effects on the thyroid and liver, and symptoms similar to those of attention deficit hyperactivity disorder (ADHD), says Aga, PhD, professor and director of graduate studies in the Department of Chemistry in the UB College of Arts and Sciences.

Firefighters, perhaps the group most at risk since their equipment is covered in flame retardants, have even begun to speak out against their

use in recent years, citing health risks.

"Flame retardants are a class of emerging contaminants of concern to human health, and they are in our environment because they were produced commercially," says Olson, PhD, professor in the Department of Pharmacology and Toxicology in the Jacobs School of Medicine and Biomedical Sciences at UB, and professor of epidemiology and environmental health and director of the Division of Environmental Health Sciences in the UB School of Public Health and Health Professions.

"Our new one-shot analysis has found that the levels of OH-BDEs are retained in the blood serum of some women at levels higher than the original BDEs. The significance is heightened by reports that OH-BDEs may be more toxic than BDEs."

Olson and Aga recently reported that an enzyme in the body is the culprit behind breaking down BDEs in our bodies into potentially more toxic OH-BDEs. The enzyme, which also plays a role in breaking down some medications, is present in all people, but varies in amount and type.

Large-scale studies have not been conducted on OH-BDEs because current methods for analysis cannot detect their presence easily in substances such as milk or blood, says Aga.

As a result, most studies have focused on the presence of BDEs, meaning researchers know little about how much OH-BDEs and MeO-BDEs are in our bodies, says Aga. The new one-shot method opens the door to studying these compounds in an efficient manner.

Solving the OH-BDE puzzle with one shot

Currently, to test samples for the presence of any of the three types of

flame retardants, researchers must first convert OH-BDEs into the more easily detectable MeO-BDEs. But to avoid false measurements and double counting, each compound must be measured separately, resulting in a series of time-consuming, expensive tests.

The new one-shot method solves the problem by converting OH-BDEs into a similar, but alternate compound, allowing all three classes to be analyzed at once without conflicting measurements.

"One-shot can make risk assessment of flame retardants more accurate because now we can include OH-BDEs in the picture," says Aga. "This new methodology can also be applied to new brominated flame retardants that have not yet been tested. It opens up many more possibilities for assessing the potential health effects and environmental impact of these compounds."

Using the one-shot technique, researchers were able to test 37 forms of brominated flame retardants at once, a step forward for identification techniques, but still a fraction of the 209 possible forms of BDEs, the majority of which have not been studied, says Aga.

BDEs: Banned, but ever present

Several forms of BDEs are no longer in use in the U.S. and European Union, with bans starting in 2003, though products containing the compounds – everything from cell phones and televisions to couches and clothes – are still in use.

And as bans are placed on more forms of brominated flame retardants, companies simply adopt another chemical whose toxicity is mostly unknown, says Aga.

Flame retardants don't bind to electronics and fabrics, and can easily

wash or brush off, making their way into the air or public water supply. Once in the environment, they bioaccumulate along the food chain, reaching humans through consumption of contaminated fish, meat or other food products.

But while flame retardants won't bind to plastic or wool, they will stick to the fat.

Foods high in fat, such as butter and cheese, have been found to contain these compounds. Once consumed, they bind to fat in the body, taking years to be eliminated, says Aga.

Because breast milk is also high in fat, newborns are at potential risk as well, as mothers can transfer the compounds to their nursing infants. This doesn't mean that new moms shouldn't breast-feed, says Olson, as the benefits of breast-feeding outweigh the potential risks for mothers who live outside of heavily polluted areas. But the presence of BDEs in breast milk should drive the public to be aware of these chemicals and their effects.

The next question: Are vulnerabilities inherited?

Olson and Aga's future research will seek to understand if genetic differences play a role in causing variances among the metabolizing enzyme found in humans and if the enzymes influence why people retain different levels of BDEs and their breakdown products, which may place some individuals at greater risk of adverse health effects.

Further studies also are needed to examine MeO-BDEs, some of which are naturally found in plants, but whose toxicity is unknown and may also have the potential to be converted into OH-BDEs by enzymes in the human body, says Aga.

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