Hello and welcome to the National Institute of Environmental Health Sciences Superfund Research Program monthly Research Brief podcast. This month's Research Brief, Number 275, was released on November 1, 2017, and discusses how activated carbon reduces the effects of TCDD on the immune system and gut microbiome in a mammalian model.

Breakthroughs from the Michigan State University Superfund Research Program Center provide new evidence that activated carbon may be used to reduce health risks resulting from dioxin contamination.

Activated carbon is produced when materials with high carbon concentrations, such as coal or wood, undergo special treatment that expose them to extremely high temperatures without burning them. The result is a porous substance that can bind with other carbon-containing chemicals. Previous studies have shown that activated carbon can sequester dioxins in the environment and reduce their bioavailability to aquatic invertebrates, or the fraction of the chemical that can be taken up by organisms. For the first time, these studies provide direct evidence that activated carbon also reduces dioxin availability to mammals.

In one study, Michigan State researchers led by Stephen Boyd show that when mice ingest 2,3,7,8-tetrachlorodibenzo-p-dioxin (or TCDD) absorbed to activated carbon, the TCDD is no longer toxic to them.

Today people are exposed to dioxins primarily by eating food, particularly animal products, contaminated by these chemicals. The dioxin TCDD is a known cancer-causing agent in humans that has also been linked to type 2 diabetes, an acne-like skin disease, damage to the immune system, developmental problems in children, and infertility problems in adults.

Researchers compared mice who received oral doses of TCDD alone to mice who received TCDD absorbed to food grade activated carbon. The researchers measured two biological effects associated with TCDD exposure, the activation of Cytochrome P450 (CYP) 1A1, an enzyme important to metabolism, and suppression of a specific cell immune response to form antibodies.

They observed CYP1A1 activation and immune response suppression in mice given TCDD without activated carbon. The responses were not observed when the researchers gave the mice an equivalent amount of TCDD absorbed to activated carbon. According to the authors, this provides the first direct evidence that activated carbon can sequester TCDD in a form that is not bioavailable to mammals.

In another study, researchers led by Syed Hashsham reveal how activated carbon also reduces the effects of TCDD on microbes in the gut without itself leading to significant changes in the gut microbiome. Because the gut microbiome can play a crucial role in host health and immune response, the researchers compared the gut microbiome of mice fed TCDD alone to mice fed TCDD absorbed to activated carbon.

In mice administered TCDD alone, they saw an increase in segmented filamentous bacteria, which has been seen in previous studies with TCDD-induced host toxicity. This response was not seen when TCDD was sequestered by activated carbon.

They also looked at the influence of food grade activated carbon alone on the gut microbiome. Activated carbon had a minimal influence on gut community structure and diversity in mice. They saw a shift in diversity in only three members of the gut microbiome, including a small relative increase in the *Lactobacillaceae*, a family of lactic acid bacteria generally considered a probiotic. This also provides evidence that ingesting activated carbon, which has been used in humans as a remedy or supplement for intestinal disorders and detoxification, is not likely to significantly alter the gut microbiome.

Taken together, these results show that activated carbon can be used to reduce or eliminate the bioavailability of TCDD in mammals. While previous studies documented the capacity of activated carbon to sequester dioxins, questions still arose as to whether the sequestered form might still be toxic to animals or humans. These results provide evidence that TCDD sequestered to activated carbon, when ingested, is not toxic to mice. As a result, this suggests that when activated carbon is used in the environment to bind to TCDD, it may not be toxic to animals that are exposed to it.

Current methods for removing dioxins from contaminated soil and sediment often require dredging, an expensive and time-consuming method to remove the contaminated soil, followed by disposal in landfills. According to the authors, these findings support the use of activated carbon as a low-cost ecosystem-friendly way to reduce dioxin's bioavailability in soils, sediments, and surface waters.

If you'd like to learn more about this research, visit the Superfund Research Program website at www.niehs.nih.gov/srp. From there, click on "Who We Fund" and follow the links to the Michigan State University research summary. If you have any questions or comments about this month's podcast or if you have ideas for future podcasts, contact Maureen Avakian at avakian@niehs.nih.gov.

Join us next month as we discuss more exciting research and technology developments from the Superfund Research Program.