Monitoring Dioxins

Dioxins, a family of 210 compounds of which 17 are considered toxic and virtually nonbiodegradable, pose an environmental hazard that may be watched even more closely with the advent of technology being developed by Agricultural Research Service scientists.

Produced by natural and industrial processes, dioxins are chlorinated aromatic compounds that can build up in fatty tissue and may increase the risk of tumors and possibly other undesirable health effects. Some forms, or congeners, of dioxins are more toxic than others. One, known chemically as 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, is so toxic that, according to U.S. Environmental Protection Agency (EPA) standards, less than 0.1 milligram in a water supply the size of an Olympic swimming pool is enough to render the water unfit for drinking.

Water, however, is not a major source of dioxin exposure for humans. A more usual source is our food supply, for example, food products from animals that have eaten feed contaminated by the fat-soluble chemical, says chemist Janice K. Huwe, lead scientist in dioxin research at the ARS Animal Metabolism-Agricultural Chemicals Research Unit at Fargo, North Dakota.

A case in point: In 1997, USDA Food Safety and Inspection Service inspectors sampled chicken meat being sold in Mississippi and found it high in dioxins. The ARS scientists in Fargo, working with EPA, helped uncover the extent of contamination and ferreted out the source.

The researchers traced the dioxin to chicken feed, specifically soybean meal. Ball clay, which is naturally contaminated by dioxins, had been used as a desiccant, or drying material, to enhance the soybean meal's flowability during processing. FDA has since recommended that clays used as desiccants in feed processing be tested for dioxin.

More recently, high levels of dioxin showed up in some foods of animal origin produced in Belgium. Food recalls and temporary international trade restrictions followed. In this instance, the dioxin source was traced to contaminated animal fats that had been added to chicken feed and other animal feedstuffs.

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Technician Marge Lorentzsen loads dioxin samples into a gas chromatograph/mass spectrometer (GC/MS) autoinjector for analysis.

A Burning Concern

Dioxins are in the family of chemicals called chlorinated hydrocarbons. From time immemorial, they have been formed by wood combustion. In modern times, their formation has come from garbage incinerated at temperatures below 1,800˚F, the manufacture and use of some herbicides, chlorine bleaching of wood pulp and paper, and other industrial processes.

Given that these processes may release dioxins into the atmosphere, EPA also began to consider, 7 years ago, the possible importance of air pollution in the dioxin contamination of forage and other livestock feeds.

In a USDA fact-finding mission to investigate the extent of dioxin contamination in livestock from all sources, the Fargo team researched dioxins in beef. They collected and analyzed beef samples from 13 states, including Hawaii. "By and large, we found the samples were clean, with some outstanding exceptions in the kidney fat of some individual carcasses," says Huwe. Samples with high dioxin levels were found to have come from animals raised in barns or pens containing posts that had been treated with dioxin-containing pentachlorophenol (penta) to prevent rotting.

Now, according to EPA regulations, wood preservatives used for fence posts or feeding troughs in barns can no longer contain penta. And penta sold in the United States for uses such as preserving utility poles must now be manufactured under conditions that do not produce 2,3,7,8-tetrachlorodibenzo-*p*-dioxin and that minimize the concentration of another toxic congener, 1,2,3,6,7,8-hexachlorodibenzo-*p*-dioxin. No single batch of penta can have levels higher than 4 parts per million (ppm), and the average concentration among batches must not exceed 2 ppm.

Tracing Toxins

The scientists at Fargo are identifying routes of exposure and distribution of the 17 toxic congeners in animals being raised for food and how this affects our food supply. Pioneering research by ARS chemist Vernon J. Feil (retired) and his colleagues on some of the less toxic congeners is helping to advance studies on others.

After feeding different congeners of dioxins to laboratory and farm animals, the scientists determine what happens to the molecules. For example, do the dioxins end up in meat? And if so, are they converted to forms that are any more or less dangerous to health than the original congeners?

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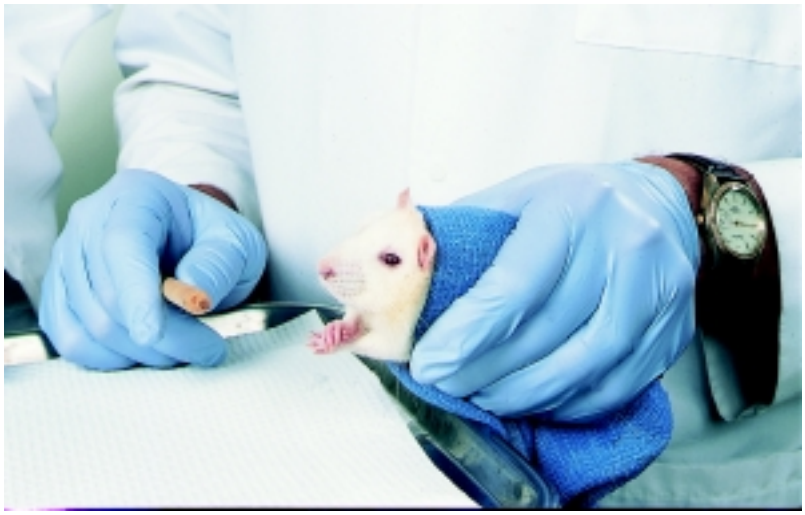
Chemists Gerald Larsen (left) and Heldur Hakk prepare to dose a rat for a metabolism study.

PEGGY GREB (K9223-1)

Chemists Richard Zaylskie and Janice Huwe process data from a high-resolution GC/MS dioxin analysis.

In other research, ARS chemists Heldur Hakk and Gerald L. Larsen and animal physiologist Nancy W. Shappell are exploring methods to minimize the burden of dioxin compounds that persist in animals' bodies. These methods involve either decreasing the amounts assimilated from feed or increasing the efficiency of biochemical pathways to excrete them.

PEGGY GREB (K9225-1)



In laboratory studies, ARS scientists determine what happens to dioxin compounds after they are fed to rats.

With new technologies, the scientists are now making headway in the research—at lower costs. When research began, dioxin analysis cost nearly $2,000 per sample. It's now down to about $600 to $800 per sample. Huwe and chemist Weilin L. Shelver at Fargo are developing an even more efficient procedure—an immunoaffinity column method—which requires minimal use of chemical solvents for the isolation of dioxins from foods. They expect analysis costs with the new method will eventually drop to $300 or $400 per sample. One of several antibodies used in the procedure was created through research by ARS biologist Larry H. Stanker (formerly at College Station, Texas).

The Food Safety and Inspection Service plans to resurvey beef, pork, and chicken for dioxin contamination to get a better picture of the background levels in the U.S. food supply.

Such knowledge came in handy last year when a beef sample exported to Japan had high dioxin levels. It turned out that, in this isolated incident, the particular congener involved was one of the least toxic. No further problems have been found in shipments of U.S. beef to Japan.—By **Ben Hardin,** ARS.

This research is part of Food Safety, an ARS National Program (#108) described on the World Wide Web at http://www.nps.ars.usda.gov.

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