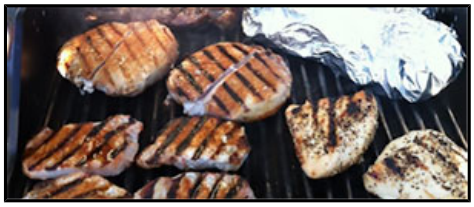
Study identifies novel compounds more mutagenic than parent PAHs

By Sara Mishamandani

Researchers at Oregon State University (OSU) have discovered novel breakdown products that form when specific high molecular weight polycyclic aromatic hydrocarbons (PAHs) chemically interact with nitrogen. These nitrated-PAHs (NPAHs), which were not previously known to exist, are more mutagenic than their parent PAH compounds.



NPAHs are produced by certain types of chemical reactions, such as those found in grilling meat. (Photo courtesy of Oregon State University)

Mutagens are physical or chemical agents that change the genetic material of an organism, increasing the frequency of mutations. Because many mutations cause cancer, mutagens are likely to also be carcinogens, or agents directly involved in causing cancer.

"Some of the compounds that we've discovered are far more mutagenic than we previously understood and may exist in the environment as a result of heavy air pollution from vehicles or some types of food preparation," said Staci Simonich, Ph.D., *(http://emt.oregonstate.edu/stacisimonich)* professor of chemistry and toxicology in the OSU College of Agricultural Sciences and Superfund Research Program (SRP) researcher.

Simonich has also done extensive work on urban air quality, specifically related to PAHs found in particulate matter, which is a concern for air pollution. (Photo courtesy of Narumol Jariyasopit)

The study, *(http://www.ncbi.nlm.nih.gov/pubmed/24350894)* led by Simonich, was published in January in the journal Environmental Science and Technology.

Understanding the formation of NPAHs

PAHs are present in fossil fuels and are also formed by incomplete combustion of carbon-containing fuels, such as wood, coal, diesel, and tobacco. Many PAHs, such as benzo[a]pyrene, are known carcinogens.

Researchers investigated the reactions of five mutagenic, high molecular weight PAHs in experiments that mimicked conditions similar to those found in the Earth's atmosphere. They also conducted a theoretical study to understand the formation of NPAHs. The team discovered that nitrogen dioxide (NO_2) and nitrate (NO_3)/dinitrogen pentoxide (N_2O_5) were effective oxidizing agents in transforming PAHs to NPAHS.

According to the OSU press release, *(http://oregonstate.edu/ua/ncs/archives/2014/jan/new-compounds-discovered-are-hundreds-times-more-mutagenic)* NPAHs raise further concerns about the health impacts of heavily-polluted urban air and dietary exposure, although it has not yet been determined in what level the compounds might be present, and no health standards now exist for the compounds.

Rising concerns on health effects

By performing mutagenicity assays, researchers found that, for all the PAHs tested, the NO_3/N_2O_5 exposure resulted in a 6-fold to 432-fold increase in direct-acting mutagenicity.

The study measured the breakdown of specific PAHs by substituting deuterium for hydrogen in the PAHs, causing NPAHs to be formed. Researchers found that the substitution of deuterium lowered the mutagenicity of the NPAHs, suggesting the results from the mutagenicity assays may actually understate the increase in toxicity.

This study grew from PAH pollution work of OSU SRP. As SRP works to identify remediation technologies that break down PAHs in soil and sediment, Simonich is assessing the PAH breakdown products, to determine which remediation techniques minimize the formation of these potentially hazardous products.

The study was supported by NIEHS and the National Science Foundation. Collaborators on the study included researchers from OSU; the University of California, Riverside; and Texas A&M University.

Citation: Jariyasopit N, McIntosh M, Zimmermann K, Arey J, Atkinson R, Cheong PH, Carter RG, Yu TW, Dashwood RH, Massey Simonich SL.
(http://www.ncbi.nlm.nih.gov/pubmed/24350894)
2014. Novel nitro-PAH formation from heterogeneous reactions of PAHs with NO2, NO3/N2O5, and OH radicals: prediction, laboratory studies, and mutagenicity. Environ Sci Technol 48(1):412-419.

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