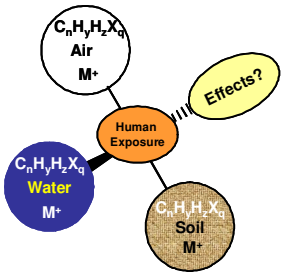


Superfund Research Program
University of California Davis

Dr. Bruce D. Hammock, Director

Research Update No. 6 **Sept 2013**

Introduction

The primary purpose of this Research Update is to inform staff in State and Federal government involved in legislation and regulation of toxic substances in the environment about research results emanating from the UC Davis Superfund Program. Additionally, others involved in the mitigation and assessment of toxic substances in the environment may find some value in these updates. The goal of these updates is to provide information about the National Institutes Environmental Health Sciences (NIEHS) funded Superfund Research Program (SRP)[1] that has been at UC Davis for the past 27 years. This national program was initiated to address human and environmental problems such as Love Canal, NY where improper disposal of chemical wastes occurred or Times Beach where oil containing chlorinated dioxins was sprayed as a dust suppressant. The mission of the SRP is stated below[2]

> "*Since its inception in 1987, the SRP has applied a multidisciplinary approach to basic research focused to provide a solid foundation which environmental managers and risk assessors can draw upon to make sound decisions related to Superfund and other hazardous waste sites. We believe that basic research plays a crucial role in addressing challenges posed by environmental contamination such as health risks, toxicity, exposure predictions, fate and transport, and the need for* cost-effective treatments for hazardous *waste sites found throughout the United States"*

The Superfund Program at UC Davis[3] has provided basic research information to address these needs. We continue to develop innovative, novel technology to investigate human exposures, environmental fate and transport of toxic substances, as well as cost-effective methods for the treatment and remediation of these chemicals. The success of our program is due to the breadth of the multidisciplinary approach to these complex scientific issues of chemical exposure that continue to pose hazards to human and environmental health.

This program exports its findings beyond academic journals and publications to other venues and audiences. As required by the NIEHS, we have concerted efforts to effectively partner with government, transfer technology to commercial ventures, or communicate with broader public audiences for the purpose of improving human and environmental health. Research Translation of scientific results is important for society to understand the goals of the SRP in the mitigation of toxic substances in the environment.

This newsletter highlights three relevant areas of research from the program:

1) Not all biochars are created equal
2) Metabolites of polyunsaturated fats possess different and potentially beneficial effects on cancer
3) Researcher Highlight - Thomas M. Young, Ph.D.: UC Davis Researcher to assess the research integrity of EPA's hydraulic fracturing report

[1] Name changed from Superfund Basic Research Program to Superfund Research Program in 2008
[2] www.niehs.nih.gov/research/supported/srp/about/index.cfm
[3] www-sf.ucdavis.edu/

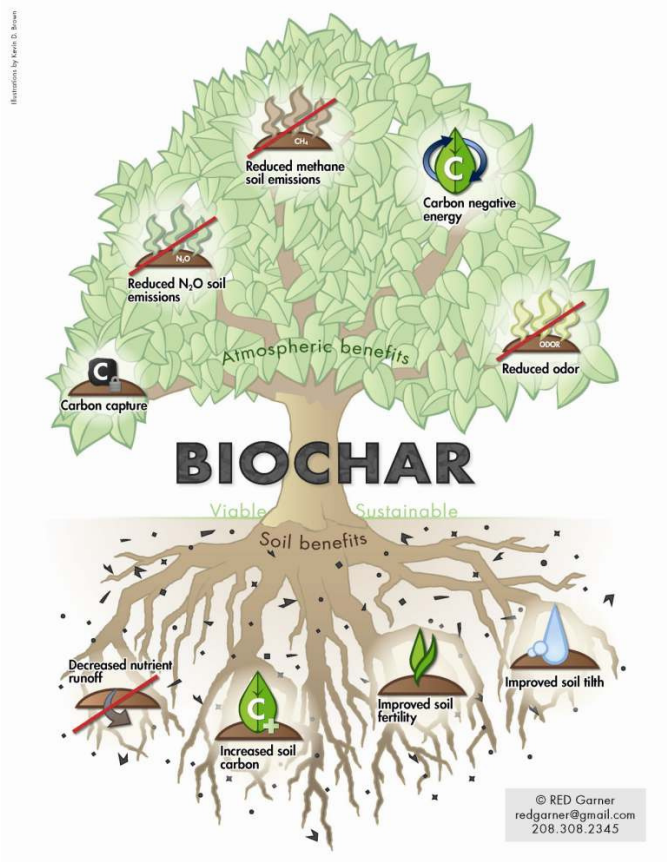
1) Not all biochars are created equal

Background

Whether you are interested in increasing crop yields or sequestering carbon dioxide emissions, a new type of soil amendment material, known as biochar, may be able to help. Put simply, heating biomass to very high temperatures in the absence of oxygen produces what is known as 'biochar'. Biochar is used as a soil amendment for agricultural purposes. The technique of using charcoal to improve the fertility of soils originated in the Amazon basin at least 2,500 years ago.

There are many proposed advantages of adding biochar to soil, such as: reducing soil emissions of greenhouse gases, nutrient leaching, and fertilizer requirements; and retaining more water. Due to very slow degradation, biochar sequesters large masses of carbon and can play an important role in global climate change if used on a large scale.

All of these positive qualities are dependent on the properties of the biochar, which vary widely among different biochars, depending upon the starting feedstock (ranging from a variety of agricultural by-products such as wood-chips, nut shells, animal litter, algal biomass, etc.) and production process (such as temperature).



Impact

A scientific understanding of how biochar properties impact the potential benefits is inadequate. It is difficult for end users to make informed decisions regarding the specific biochar properties to consider when selecting a particular biochar for their use. Therefore, researchers at the UC Davis Superfund Research Program are studying the differences among biochars. In order to document these differences, they have developed a Biochar Database [biochar.ucdavis.edu], which serves as an open-access tool for biochar users, manufacturers and researchers to learn about as well as submit information on properties of different biochars.

Furthermore, the high surface area of biochar has the ability to adsorb a variety of chemicals. Biochar is used in combination with other agricultural amendments, such as biosolids. Biosolids are a by-product produced during treatment of wastewater and are rich with nutrients, but can potentially contain pharmaceuticals, household chemicals, and heavy metals at high concentrations. The presence of these harmful chemicals is undesirable in agricultural use as they can eventually transfer to the foods we eat. Researchers at the UC Davis SRP are studying the potential of biochar, if added along with biosolids, to decrease plant uptake of these harmful chemicals found in biosolids.

2) Metabolites of polyunsaturated fats possess different and potentially beneficial effects on cancer

Background

Do you pay attention to the fat you eat? Most know to look for **saturated** and **unsaturated** fat, but do you know the difference between **omega-6** (ω-6) and **omega-3** (ω-3) polyunsaturated fats (PUFAs)? Professor Bruce Hammock and a team of researchers from the Superfund Research Program at the University of California - Davis can tell you - as recently they have been studying the impact of PUFAs on many chronic diseases including pain and cancer.

While most people are generally concerned about the caloric content of fat, PUFAs also have potent biological activity. Like antioxidants or vitamins, PUFAs are necessary precursors converted to several chemicals including both the pro-inflammatory prostaglandins and anti-inflammatory epoxy-fatty acids (EpFAs). Common pain relievers including aspirin, acetaminophen or ibuprofen, work by suppressing the production of

these pro-inflammatory prostaglandins. In contrast, the anti-inflammatory EpFAs are degraded by an enzyme, the soluble epoxide hydrolase enzyme, which makes it a promising target for drug development - by hampering this enzyme, the anti-inflammatory chemicals will hang around longer.

Impact

So where do ω-6 and ω-3 fatty acids come in? Well, in a recent publication in the *Proceedings of the National Academy of Sciences*, researchers in the Hammock laboratory found that a metabolite of a common ω-3 fatty acid, docosahexaenoic acid (DHA), typically associated with fish oil, significantly stunted the growth of implanted primary tumors and reduced the occurrence of secondary tumors in mice. In comparison, the metabolite of arachidonic acid, an ω-6 fatty acid, actually increased the growth of implanted primary tumors. Although both ω-3 and ω-6 EpFAs decrease inflammation, in this case the discrepancy between ω-3 and ω-6 fatty acids lies in their ability to regulate angiogenesis, the growth of new blood vessels. By shutting off the tumor's blood supply, the tumor does not grow or spread.

It can't be that easy right? To confound the issue, some environmental chemicals can induce or inhibit this pathway. This means that exposure to environmental chemicals - in addition to diet - influence the production of these metabolites.

Nonetheless, the benefits of ω-3 fatty acids seem to be a common theme throughout cancer literature. This research shows that diet supplementation may be complex and require more than a simple change in diet to obtain the best protection from cancer. Additionally, it shows that therapeutic drug development needs to be guided by multiple factors – including environmental and dietary exposures.

3) Researcher Highlight - Thomas M. Young, Ph.D.: UC Davis Researcher to assess the research integrity of EPA's hydraulic fracturing report

Hydraulic fracturing (a.k.a. hydro fracturing or fracking) is the process of injecting a fluid mixture of sand, water and chemicals into shale rock formations in order to extract fossil fuels trapped inside. The safety of hydraulic fracturing is intensely debated: opponents argue the process contaminates ground water, depletes fresh water supplies and increases noise and air pollution to an unacceptable level in communities where hydrofacturing wells exist; advocates argue that the process is highly regulated by the government, and the economic opportunities far outweigh potential environmental risks.

In response to the growing concern over the safety of hydraulic fracturing, Congress requested a comprehensive report from the EPA. The report, *Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources*, is scheduled for release in 2014. In an effort to show transparency and integrity in the report, EPA appointed an independent review panel composed of people from both industry and academia to review the study in regards to scientific rigor and conflicts of interest. Of the 144 qualified experts considered for the panel, 31 were selected, including UC Davis Superfund Researcher Thomas Young.

Dr. Young's research focuses on controlling the fate and transport of contaminants in the environment and identifying experimental and modeling work required to proactively manage toxic chemicals to reduce their life cycle environmental impacts. Before joining the faculty at UC Davis, Dr. Young worked as a regulator for the US EPA. His expertise and training are valuable assets for the review panel.

This newsletter continues to evolve to improve its intended purpose. Therefore, we value critique so that in the future it will improve and therefore better meet the needs of the recipients. Some areas on which we would like comment are content, effectiveness of communication and how it can build interactions and relationships with others outside the UC Davis Superfund Research Program. Please share this Research Update with your colleagues who may have an interest in the results of our research.

For more information about the UC Davis SRP, please contact:
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