Model Predicts PAH Levels in Important Tribal Food Source

A sediment passive sampling model can be used to accurately predict the concentration of polycyclic aromatic hydrocarbons (PAHs) in butter clams, according to a recent Superfund Research Program (SRP) study.

PAHs are a large group of hazardous chemicals commonly found at Superfund sites and have been linked with health effects, including cancer. In Puget Sound, PAHs are found in the sediment where butter clams are harvested. Butter clams are an important food source and component of cultural practices for local tribes, but PAHs can accumulate in the edible portion, posing a health risk to the communities who rely on them.

Led by Kim Anderson, Ph.D., of the Oregon State University (OSU) SRP Center, the research team worked closely with tribal leaders to better predict PAH levels in butter clams while having a minimal impact on this important resource.

Traditional approaches to predict the levels of contaminants in sediment-dwelling organisms use measured total sediment concentrations and mathematically relate that to the amount that is likely to be readily taken up by the organism, a term known as bioavailability. According to the authors, this approach is not very accurate and tends to overestimate the amount of a chemical that will accumulate in animals by a factor of 10 to 44.

In contrast, the OSU team used sediment porewater passive samplers to measure freely dissolved PAHs, which may be a better predictor of bioavailability, accumulation, and toxicity for these organisms. Porewater is the water that exists between particles of soil and sediment. The researchers collected butter clams from four different tribal fishing sites selected by the community and placed their low-density polyethylene passive sampling devices (PSDs) in each of the empty clam holes for 29 days.

The team then compared the concentration of PAHs in the edible portion of the butter clams with the concentrations measured by the PSDs and used a mathematical model to predict PAH concentrations in butter clams based on PSD measurements.

Overall, the team detected 42 different PAHs in the porewater or clams and found similar profiles of PAHs in porewater and clams from the same site. The concentrations of PAHs in the porewater and clams were correlated, supporting the premise that the freely dissolved PAHs in the sediment porewater are likely to accumulate in the clams.

Using the 42 detected PAHs, the team generated a mathematical model that could predict the concentration of PAHs in butter clams within a factor of 1.9 from the freely dissolved PAH concentration in porewater. Interestingly, in contrast to traditional models, this model suggests that PAH accumulation in clams does not continue to increase linearly as PAH concentration in porewater increases. Instead, at high PAH concentrations in porewater, the rate of PAH accumulation in clams decreases. According to the authors, this effect may represent biological processes that help organisms detoxify contaminants.

The passive sampling model developed by the OSU SRP team offers a sustainable, simple, and accurate approach to predict the concentration of PAHs in clams, the authors say. They argue that this tool is particularly important for assessing risk among Native American populations who consume more of these clams and other shellfish than the national average and, therefore, may be at greater risk for health impacts such as cancer.

Anderson and her team also have collaborated with the Swinomish Indian Tribal Community to use personal passive sampling wristbands that she developed with SRP and other NIEHS funding to measure exposure to PAHs from nearby oil refineries.

Through this community-based participatory research project, the team observed differences in PAH exposure for individuals who participated in different activities or lived at different distances from the refineries. At the end of the study, participants reported that they felt more aware about their potential exposure to PAHs from different sources and, in many cases, felt empowered to take steps to reduce their exposure.

The silicone wristbands can capture and measure a large number of diverse compounds at environmentally relevant concentrations and have been shown to more accurately capture exposures in the body compared to traditional air monitors. Using these simple devices, the OSU team and colleagues from other institutions recently discovered common chemical exposures across continents. They detected 191 unique chemicals in 262 individuals in four countries. While chemical exposures varied among individuals, many were exposed to similar chemical mixtures. According to the team, these wristbands have been incredibly useful in uncovering personal exposure trends that may help prioritize certain mixtures and chemical classes for future studies.

If you’d like to learn more about this research, visit the Superfund Research Program website at niehs.nih.gov/srp. From there, click on the Research Brief title under the banner, and refer to the additional information listed under the research brief. If you have any questions or comments about this month’s podcast, send an email to srpinfo@niehs.nih.gov.

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