Environmentally Persistent Free Radicals, PAHs Interact to Increase Toxicity of Particulate Mixtures

A class of toxic air pollutants known as environmentally persistent free radicals, or EPFRs, may interact with certain polycyclic aromatic hydrocarbons, or PAHs, on the surface of airborne particulate matter, converting PAHs into more toxic forms, according to researchers funded by the NIEHS Superfund Research Program, or SRP. The study, led by Slawomir Lomnicki at the Louisiana State University SRP Center, demonstrated that the synergy between components of fine particulate matter mixtures may enhance the mixture's overall toxicity.

Particulate matter refers to small particles that are suspended in the air. Inhaling particles smaller than 2.5 micrometers, called PM2.5, like those that make up smoke or smog, is especially hazardous and is associated with a higher risk of heart disease and asthma. Because PM2.5 is a complex mixture of many different components, it is unclear which constituents contribute most to the toxicity of PM2.5.

Two common components of PM2.5 mixtures are EPFRs and PAHs. EPFRs are formed during combustion and are linked to respiratory and cardiovascular issues. When they encounter liquids, such as body fluids, EPFRs form a hydroxyl, abbreviated as *OH,* free radical, a molecule that can take electrons from other molecules in a process known as oxidation. PAHs, which are primarily released from burning fossil fuels and plant matter, can be converted into oxy-PAHs by oxidation. Oxy-PAHs are highly toxic and are associated with DNA damage and various cancers.

The researchers hypothesized that EPFRs and PAHs may react together in PM2.5 mixtures to form oxy-PAHs. To test their hypothesis, they used a PM mixture of copper-coated silica and covered the particle surfaces with EPFRs. According to the scientists, they chose to make the EPFR mixture in the lab to control the composition of the PM mixture and ensure that no other interactions were oxidizing the PAHs.

The team then added a PAH to the particulate matter mixture containing EPFRs, and to a control group of only copper-coated silica particulate matter. Next, the scientists suspended the two mixtures in water at two different temperatures, room temperature (25°C) and human body temperature (37°C). Both suspensions were shaken for 18 hours to allow any reactions to occur. Then, they measured the suspensions for the presence of oxy-PAHs.

The researchers found oxy-PAHs in the suspensions of particulate mixtures containing EPFRs at both temperatures, while almost no oxy-PAHs were detected in the control suspensions. According to the scientists, this suggests that EPFRs oxidize PAHs when the two contaminants are present in particulate matter mixtures. Additionally, the EPFR suspension at 37°C contained higher levels of oxy-PAHs. This may indicate that the rate of PAH oxidation increases with temperature, the authors stated.

According to the team, this study demonstrates that PM particles with both EPFRs and PAHs on their surfaces may have increased toxicity due to the formation of oxy-PAHs. This may be one contributing factor in the toxicity of PM2.5 mixtures, they added.

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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