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Human Colon Microbiota Transform Polycyclic Aromatic Hydrocarbons To Estrogenic Metabolites

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Estrogenic PAH metabolites from colon microbiota

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Abbreviations:

PAH: polycyclic aromatic hydrocarbon

EE2: 17α ethynyl estradiol

LC-MS: liquid chromatography – mass spectrometry

Ah: Aryl hydrocarbon

GI: gastrointestinal

DW: dry weight

GC-MS: gas chromatography – mass spectrometry

SHIME: simulator of the human intestinal microbial ecosystem

Abstract.

Ingestion is an important exposure route for polycyclic aromatic hydrocarbons (PAH) to enter the human body. Although the formation of hazardous PAH metabolites by human biotransformation enzymes is well documented, nothing is known about the PAH transformation potency of human intestinal microbiota. Using a gastrointestinal simulator, we show that human intestinal microbiota can also bioactivate PAHs, more in particular to estrogenic metabolites. PAH compounds are not estrogenic and indeed, stomach and small intestine digestions of 62.5 nmol naphthalene, phenanthrene, pyrene and benzo(a)pyrene showed no estrogenic effects in the human estrogen receptor bioassay. In contrast, colon digests of these PAH compounds displayed estrogenicity, equivalent to 0.31, 2.14, 2.70 and 1.48 nmol 17α ethynyl estradiol (EE2), respectively. Inactivating the colon microbiota eliminated these estrogenic effects. Liquid chromatography – mass spectrometry (LC-MS) analysis confirmed the microbial PAH transformation by the detection of PAH metabolites 1-hydroxypyrene and 7-hydroxybenzo(a)pyrene in colon digests of pyrene and benzo(a)pyrene. Furthermore, we show that colon digests of a PAH contaminated soil (simulated ingestion dose of 5 g d^{-1}) displayed estrogenic activity equivalent to 0.58 nmol EE2, whereas stomach or small intestine digests did not. Although the matrix in which PAHs are ingested may lower the exposure concentrations in the gut, our results imply that the PAH bioactivation potency of colon microbiota is not eliminated by the presence of soil. Moreover, since PAH toxicity is also linked to their estrogenicity, the PAH bioactivation potency of colon microbiota suggests that current risk assessment may underestimate the risk from ingested PAHs.