

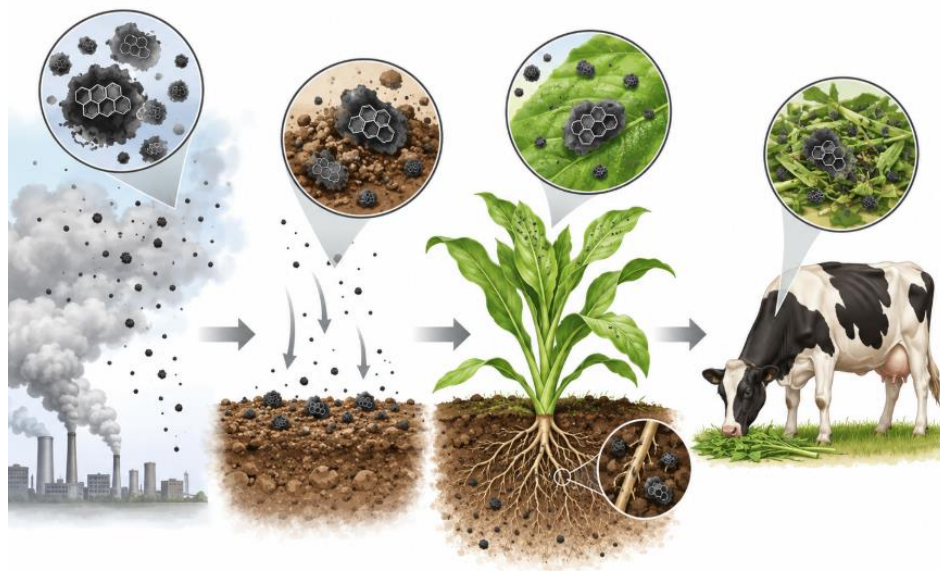
ENVIRONMENTAL PERSISTENCE AND TRANSFER THROUGH THE FOOD CHAIN

Polycyclic aromatic hydrocarbons (PAHs) in food may originate not only during processing but also in the environment in which a plant or animal grew. Understanding this pathway requires distinguishing three concepts: persistence, a substance's ability to remain in the environment; bioavailability, the proportion actually accessible to organisms; and bioaccumulation, an increase in concentration within an organism resulting from the balance between uptake and elimination. These properties vary among PAHs.

FROM THE ATMOSPHERE TO SOIL AND WATER

Many PAHs produced by combustion enter the atmosphere as gases or attached to particles. Dry deposition and rainfall may carry them to farmland, plant surfaces, streams and water bodies. Environmental contamination can also arise from petroleum spills, industrial residues and contaminated materials. Environmental contamination does not always lead to food contamination: concentration, physicochemical form, contact time and organism type all matter.

Lighter PAHs generally tend to be more volatile and relatively more water-soluble, whereas those with more aromatic rings often have greater affinity for particles and organic matter. This is a general trend, not a strict division: temperature, composition of the medium and molecular structure influence how each substance behaves.



SOIL AS A RESERVOIR, BUT NOT AN UNLIMITED SOURCE

Once PAHs reach soil, they can bind to organic matter and, to varying extents, carbonaceous particles such as soot and black carbon. This adsorption often slows their mobility and reduces the fraction readily available to microorganisms and roots. The apparent paradox is that PAHs may be measurable in soil for a long time while only some of the total amount is accessible to organisms at any particular moment.

Microbial degradation is an important natural attenuation pathway, especially under favourable aerobic conditions. More complex molecules are generally less readily degraded, but there is no single 'residence time' applicable to all PAHs and soils. Oxygen, temperature, moisture, nutrient availability, microbial populations and the progressive ageing of contamination all affect process rates.

FROM SOIL TO PLANTS: DIFFERENT ROUTES

Plants may encounter PAHs through dust and aerosol deposition on exposed surfaces, uptake of compounds from the gas phase and, under some circumstances, root uptake. For several heavier PAHs with low solubility and strong soil adsorption, movement from roots to above-ground parts may be limited. Surface contamination of leaves may consequently be more significant than systemic uptake.

The concentration in fruits or vegetables cannot reliably be inferred from soil concentration alone. Relationships differ among leafy crops, roots, tubers and fruits, depending on where contamination occurs and whether particles adhere to surfaces. Washing, removing outer layers and peeling may reduce surface contamination without guaranteeing removal of every residue or any fraction already incorporated into tissues.

WATER AND SEDIMENTS: WHY FILTER FEEDERS REQUIRE ATTENTION

In aquatic environments, a substantial fraction of PAHs, especially more hydrophobic compounds, associates with suspended particles and settles in sediments. Sediments may act as lasting reservoirs, but not all retained substances are necessarily available: release depends on sediment characteristics, resuspension and local conditions.

Bivalve molluscs and other filter feeders can take up PAHs from water, particles and filtered food. Their ability to metabolise certain compounds may be lower than that of many fish, sometimes contributing to greater accumulation in tissues. Actual concentrations nevertheless depend on species, habitat, season and duration of exposure.



BIOACCUMULATION DOES NOT NECESSARILY MEAN BIOMAGNIFICATION

Two phenomena are often confused. Bioaccumulation concerns the increasing presence of a substance within an organism in relation to uptake and elimination. Biomagnification, by contrast, means a systematic increase in concentrations from one trophic level to the next, for example from prey to predators.

For PAHs, the biomagnification model typical of some persistent contaminants, such as methylmercury, should not be applied automatically. Many organisms, particularly numerous vertebrates, can metabolise and eliminate PAHs; published evidence does not indicate generalised biomagnification in aquatic food webs. This does not exclude accumulation in particular species or circumstances: behaviour must be assessed for each substance and organism.

PERSISTENCE, CONTAMINATION AND RISK: THREE DIFFERENT QUESTIONS

Environmental persistence signals the possibility of a source causing exposure over time, but does not itself measure risk to consumers. Assessing dietary exposure requires the concentration of individual PAHs in food as actually consumed, amounts eaten and consumption frequency. Differences in toxicological properties among PAHs are also essential.

Environmental and food investigations therefore answer complementary questions: the former identify sources and transfer pathways, whereas the latter measure what reaches consumers. A high result in soil or sediment does not on its own establish food non-compliance; conversely, low concentrations in food do not prove the surrounding ecosystem is uncontaminated.

CONCLUSION

PAHs can move through air, soil, water and organisms, but their transfer is neither linear nor uniform. Adsorption, degradation and biological metabolism can reduce availability; atmospheric deposition, particles and sediments can maintain contact with the food chain. Understanding contamination therefore requires following the actual pathways of molecules without confusing environmental occurrence, biological accumulation and human exposure.

SCIENTIFIC REFERENCES

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