

HOW THEY ENTER THE FOOD CHAIN

Dioxins, furans and polychlorinated biphenyls (PCBs) can be present in food even at considerable distances from where they were emitted or used. Understanding their pathways requires distinguishing three stages: entry into the environment, transfer to living organisms and any increase in concentrations along food webs. Not all substances, ecosystems and species behave in the same way.

FROM AIR TO SOIL AND VEGETATION

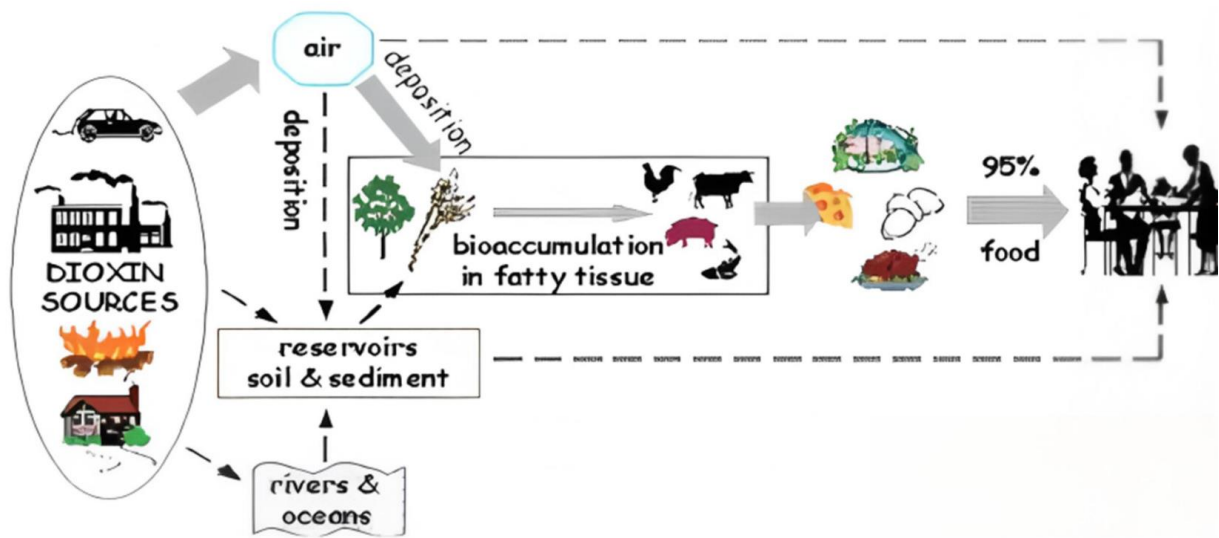
After release into the environment, some of these contaminants can travel through the atmosphere as gases or associated with particulate matter. Dry deposition and precipitation transfer them to soils, water and plant surfaces. Local concentrations depend on sources, weather conditions, compound characteristics and the history of the area. Contamination may persist in soil long after the original emissions have ceased.

On crops, deposited dust and particles can contaminate exposed parts. For many dioxins and the more hydrophobic congeners, transfer from roots to above-ground plant tissues is generally limited; this does not mean that all plant foods are free of contamination. Direct deposition and the adhesion of soil particles can be more important than root uptake, depending on the crop and growing conditions.

FROM SOIL TO FEED AND ANIMALS

On farms, the pathway does not necessarily involve uptake by plants. Cattle and sheep may ingest soil while grazing; free-range chickens may swallow soil particles as they scratch the ground. Hay, forage, feed ingredients and materials that accidentally enter the supply chain can provide additional routes of exposure.

Ingested substances are not all transferred from the digestive tract into tissues with the same efficiency. Degree of chlorination, molecular structure, food matrix and animal species affect absorption, distribution and elimination. For many persistent, lipophilic congeners, however, accumulation in animal lipids enables transfer to foods such as milk, eggs, meat and fats. Final levels depend on actual exposure and duration, not solely on the farming method.



IN AQUATIC ENVIRONMENTS: WATER, PARTICLES AND SEDIMENTS

The low water solubility of many dioxins and PCBs promotes their association with organic matter and suspended particles. These may settle and contribute to sediments that act as environmental reservoirs. Sediments are not completely isolated compartments, however: resuspension, the activity of bottom-dwelling organisms and changing environmental conditions can make some contaminant fractions available again.

Aquatic organisms can take up contaminants from water and, above all, through food. Bottom-dwelling invertebrates, small fish and predators may therefore form successive links in a food web. The relative importance of direct and dietary uptake varies with the congener, habitat and species. Fish from the same area should not be assumed to have identical concentrations.

BIOACCUMULATION AND BIOMAGNIFICATION: TWO DIFFERENT CONCEPTS

Bioaccumulation is an increase in the amount of a substance within an organism through uptake from the environment and food, when intake exceeds its capacity for transformation and elimination. The animal need not be a predator. Biomagnification, by contrast, refers to an increase in substance concentrations from prey to predator across certain trophic levels.

Lipophilicity and persistence favour both processes, but do not make them automatic or uniform. Congeners differ in absorption and metabolism, while concentrations may be influenced by fat content, age, growth and diet. The basis used to express results — per gram of food, per gram of fat or as toxic equivalents — can also change comparisons between samples.

WHY A LOCAL EMISSION MAY HAVE DISTANT EFFECTS

Atmospheric transport, waterways, movement of raw materials and trade can connect a source area to distant regions. At the same time, historical contamination can remain confined to one area for years. Distance from an industrial facility alone is therefore not a reliable indicator of the level in a food: information about origin, environmental conditions and analytical results is needed.

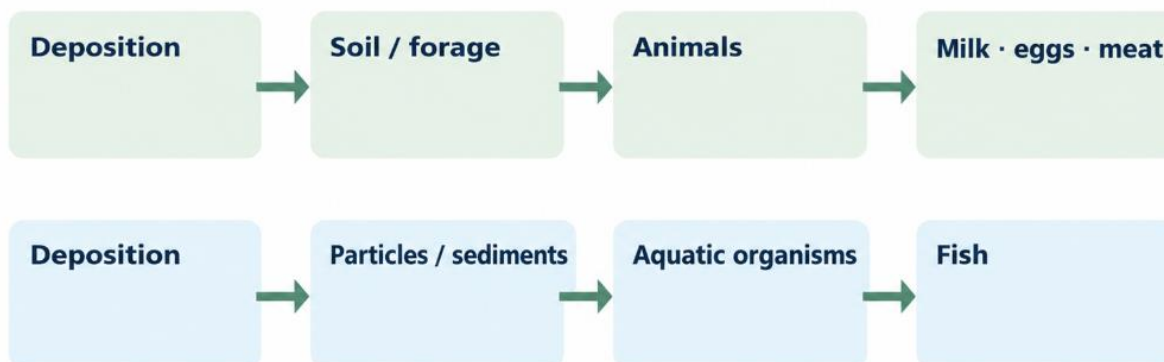
THE DECISIVE ROLE OF THE FOOD SUPPLY CHAIN

Animal-derived foods are particularly relevant because several congeners associate with lipids. This does not justify automatically classifying a whole food category as dangerous, or treating plant foods as invariably irrelevant. The combination of actual concentration, amount eaten and frequency of consumption matters. A local contamination incident must also be distinguished from widespread background environmental levels.

Controlling emissions remains essential to reduce transfer into the food chain, but it is not sufficient: monitoring affected soils and waters, selecting and checking feed ingredients and ensuring raw-material traceability are also necessary. European legislation therefore covers both food and feed. Differences between food categories and their contamination data are examined in the following chapter.

FROM THE ENVIRONMENT TO THE TABLE

Terrestrial and aquatic pathways: possible routes, not guaranteed concentrations



Transfer depends on the congener, the production chain and environmental conditions.

WHAT CAN WE CONCLUDE?

The transfer of dioxins, furans and PCBs into food is neither a single nor an inevitable process. It arises from distinct environmental and biological pathways, influenced by individual congeners and local conditions. Persistence, affinity for fats and transfer through food webs explain why monitoring cannot stop at industrial emissions and must extend to the different links of the supply chain.

SCIENTIFIC AND REGULATORY REFERENCES

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- [4. European Commission. Dioxins — Food Safety, legislative framework and technical documents.](#)
- [5. Bundesinstitut für Risikobewertung \(BfR\). Frequently asked questions about dioxins and PCBs in food.](#)
- [6. WHO \(2019\). Exposure to dioxins and dioxin-like substances: a major public health concern.](#)