

2. HOW HALOGENATED ORGANIC COMPOUNDS REACH FOOD

A contaminant may reach our table by a route quite different from the one we imagine. It may be released from an industrial material, enter air, soil or water and subsequently pass into living organisms. Alternatively, it may be transferred to food during production or processing. Understanding these processes requires distinguishing the substance's origin, the medium through which it moves and the way in which it actually enters food.

Halogenated organic compounds have very different properties: some are volatile and relatively mobile, whereas others persist in the environment and tend to associate with fats or organic matter. There is therefore no single contamination pathway that applies to the entire family.

FROM HUMAN ACTIVITIES TO THE ENVIRONMENT

Some halogenated organic contaminants arise from chemicals used in industrial processes and commercial products. Chlorinated paraffins, for example, have been used in industrial applications; certain brominated flame retardants are or have been incorporated into plastics, equipment and other materials. Emissions may occur during manufacture, use, treatment or disposal of these products.

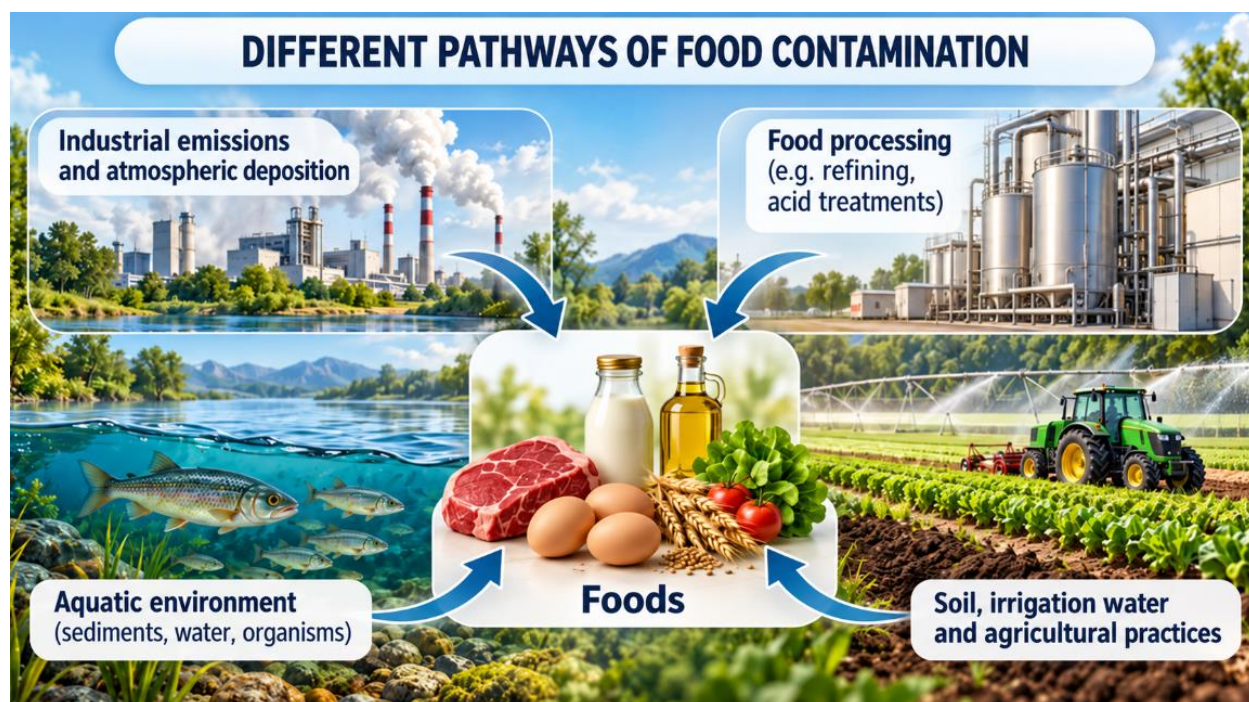
For certain substances, materials that are no longer marketed may continue to be contamination sources: substances retained in waste, sediments or existing products can sustain releases. Banning or restricting a use does not necessarily cause the substance to disappear immediately from the environment.

Not all halogenated substances, however, are persistent environmental contaminants. Their behaviour depends on chemical structure, degradability, volatility and local conditions.

AIR, WATER AND SOIL: THREE DIFFERENT PATHWAYS

In air, more volatile compounds may occur in the gas phase, while others attach to dust and particles. Atmospheric deposition can transfer them onto plant surfaces, soils and water bodies. The extent of transfer depends, among other factors, on distance from sources, substance properties and weather conditions.

In water, solubility affects the distribution between the aqueous phase, suspended particles and sediments. Poorly soluble molecules with a strong affinity for organic matter may become concentrated in sediments. This does not mean they are permanently immobilised: physical and biological processes can make them available again to organisms.



In soil, some molecules are retained by organic matter, while others may travel with pore water. Soil characteristics, organic carbon content and the time since contamination influence the availability of substances to plants and soil organisms. It should not be assumed that every compound found in soil is automatically taken up by crops.

HOW THEY ENTER PLANTS AND ANIMALS

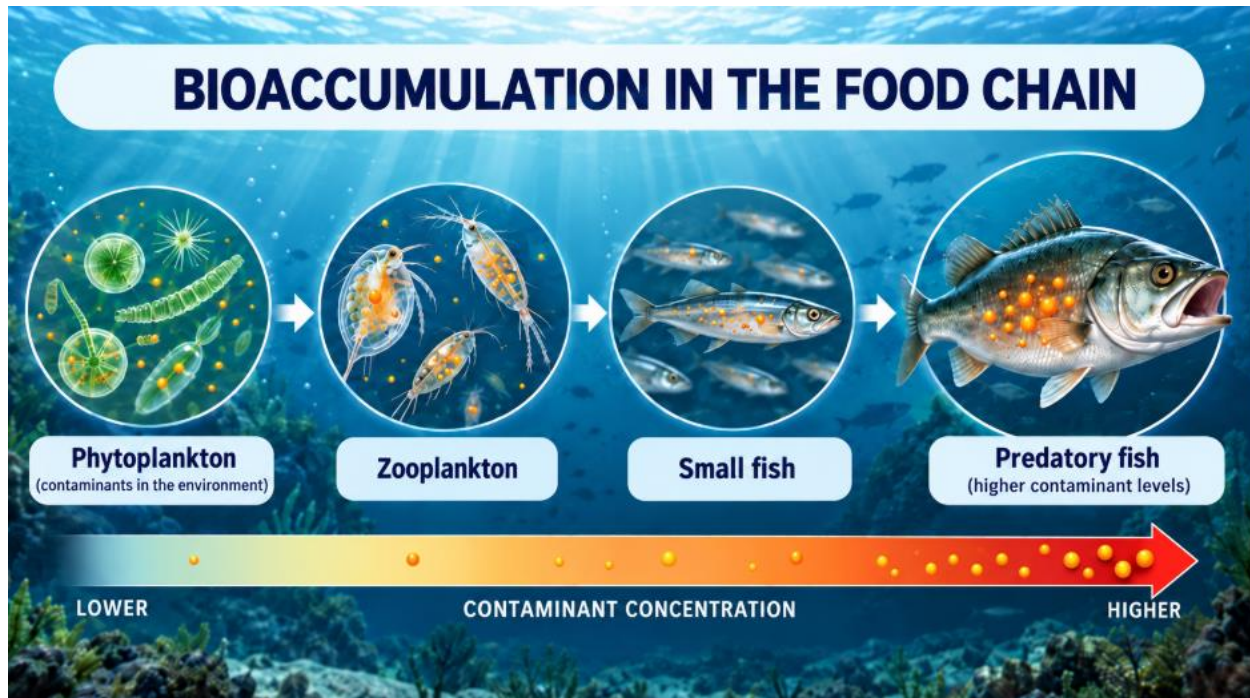
Substances may enter plants through deposition on surfaces or, in certain cases, uptake through roots. Transfer from soil into plant tissues varies considerably according to molecular properties and crop species. Soil contamination alone does not allow the concentration in a harvest to be predicted.

Animals may be exposed by ingesting feed, water, soil particles or other contaminated organisms. Some lipophilic halogenated organic compounds may preferentially enter fatty tissues; others are metabolised and eliminated more rapidly. Contamination in foods of animal origin therefore depends on both the environment and the animal's physiology, as well as the substance's properties.

EFSA assessments of brominated flame retardants describe their release from products in use or discarded products and their potential entry into the food chain, with findings particularly in animal-derived foods, including fish, meat and milk. This describes specific families, not a rule applicable to every halogenated organic compound.

BIOACCUMULATION AND BIOMAGNIFICATION ARE NOT THE SAME

Bioaccumulation occurs when a substance builds up in an organism because total uptake through water and/or food exceeds elimination over time. Biomagnification, by contrast, is an increase in concentration from one trophic level to the next along a food chain. A substance can bioaccumulate without necessarily biomagnifying in every ecosystem.



Fish and other aquatic organisms are studied extensively because they experience combined exposure through water, sediments and diet. In its 2020 assessment of chlorinated paraffins, EFSA reported evidence of accumulation in fish and potential biomagnification for some compounds. The extent of these processes depends on carbon-chain length, degree of chlorination and metabolic processes. It would be wrong to apply these observations automatically to chlorinated solvents or other molecules with different properties.

FROM RAW MATERIALS TO PROCESSING

Food contamination does not end at the agricultural stage. Additional unwanted inputs may occur during processing, packaging, storage or transport, for example through contaminated air or surfaces, where conditions allow actual transfer. Attribution to food-contact materials nevertheless requires specific evidence: finding the same substance in a material and a food product is not sufficient on its own.

Contaminants formed during manufacture are a separate case. Certain chloropropanols, including 3-MCPD and its esters, may arise under particular food-processing conditions rather than from previous soil or water pollution. A dedicated chapter examines this route: environmental contamination must not be confused with formation during processing.

WHY DETECTING A SUBSTANCE IS NOT ENOUGH

An analytical detection shows that a substance has been identified in a sample using a specified method, but it does not by itself establish its origin, the consumer's intake or the resulting risk. Exposure assessment requires information about concentration in food, consumption quantities, frequency and population groups. Risk assessment also requires reliable evidence on the toxicity of the individual substance or mixture.

The absence of a quantifiable result does not prove that a substance is completely absent. It means that, under the conditions of the method used, it was not measured above the limit of quantification. Equally, a positive result does not automatically indicate a concrete health hazard.

WHAT WE KNOW AND WHAT REMAINS UNCERTAIN

Knowledge is uneven. Some families have been investigated extensively for environmental behaviour and food occurrence; for others, evidence is fragmented. In its 2020 assessment of chlorinated paraffins, EFSA stressed that available food data were very limited and did not permit a complete risk characterisation. This is an important example: insufficient evidence neither proves that a risk necessarily exists nor allows it to be ruled out with certainty.

Understanding a substance's pathway therefore helps determine where to look for it, which samples to analyse and which results are genuinely informative. Subsequent chapters examine the individual compound families and their different behaviours without unwarranted generalisations.

SCIENTIFIC AND REGULATORY REFERENCES

[EFSA CONTAM Panel \(2020\). Risk assessment of chlorinated paraffins in feed and food. EFSA Journal, 18\(3\), 5991.](#)

[EFSA. Brominated flame retardants: overview of scientific assessments.](#)

[EFSA. Chemical contaminants in food and feed \(updated 10 January 2024\).](#)

[European Commission. Regulation \(EU\) 2023/915 on maximum levels for certain contaminants in food \(consolidated text available on EUR-Lex\).](#)