

HOW METALS ENTER OUR FOOD

When we talk about metals in food, the first question many people ask is simple: where do they come from? There is no single answer, because metals can reach our food through several pathways. Some occur naturally in the environment and are part of the composition of rocks, soils and water. Others originate, to varying degrees, from human activities: industry, traffic, combustion, mining, waste management, agricultural practices and manufacturing processes.



The mere presence of a metal in the environment does not automatically mean that a food is dangerous. What matters is the amount, the chemical form in which the metal occurs, the type of food involved, how often it is eaten and, more broadly, a person's overall exposure. The subject therefore calls for attention, but also precision: it is not enough to know that a metal exists in nature or in an environmental compartment; we need to understand whether, and to what extent, it can enter the food chain.

NATURAL SOURCES AND SOURCES RELATED TO HUMAN ACTIVITIES

Many metallic elements occur naturally in the Earth's crust. Agricultural soils, therefore, are never "empty": they already contain varying concentrations of elements such as arsenic, cadmium, lead, nickel, copper and zinc. The geology of an area can influence the concentration of certain metals in the soil and, consequently, the likelihood that they will enter the food chain.



Alongside these natural sources, however, there are also anthropogenic sources, meaning those linked to human activities. Industrial emissions, atmospheric deposition, discharges, combustion residues, road traffic, metalworking, fertilisers and other agricultural inputs can contribute to increased levels of certain metals in the environment. In many cases, contamination is invisible to the naked eye: it does not necessarily change the colour of the soil, the appearance of the water or the appearance of the final food product.

FROM SOIL AND WATER TO PLANTS

One of the main pathways by which metals enter food is their transfer from soil or water to plants. Crops absorb water and nutrients through their roots, but along with useful substances they may also take up unwanted elements present in the soil or irrigation water. Not all plants behave in the same way: different species, and even different varieties of the same species, can accumulate different amounts of the same element.

The part of the plant that we eat also matters. Some metals tend to concentrate more in roots, while others can reach leaves, seeds or fruits. This is why certain foods are more exposed than others. Rice, for example, is often a focus of attention because of arsenic; leafy vegetables can contribute to exposure to certain elements present in soil; and cereals and some vegetables can be relevant sources of cadmium in particular environmental settings.

FROM AQUATIC ENVIRONMENTS TO FISH AND SEAFOOD

Another important pathway involves rivers, lakes, coastal waters and marine environments. Metals can enter water through natural processes or as a result of discharges, atmospheric deposition and other environmental pressures. From there, they may enter aquatic organisms and, in some cases, accumulate along the food chain.

The best-known example is mercury, particularly in the form of methylmercury, which tends to accumulate in fish and to reach higher concentrations in large, long-lived predatory species. Not all fish therefore have the same risk profile: species, size, age and geographical origin can make a substantial difference. This is precisely why scientific assessments distinguish between fish categories, consumption levels and more sensitive population groups, such as pregnant women and children.

ANIMAL FEED, FARMING AND TRANSFER INTO FOODS OF ANIMAL ORIGIN

Metals can also reach foods of animal origin through feed and the farming environment. Animals consume water and plant-based feed, and some of the elements present may be transferred to tissues, milk, eggs or other products. Again, transfer is not the same for every element: it depends on the animal's metabolism, the duration of exposure and the specific characteristics of the metal or metalloid concerned.

In general, foods of animal origin do not all warrant the same degree of attention for every element. Certain organs, such as the liver and kidneys, can accumulate particular substances more readily than muscle tissue. This explains why scientific authorities and official monitoring programmes often distinguish not only between animal species but also between different food matrices.

PROCESSING, TRANSPORT AND CONTACT WITH MATERIALS

The journey does not end in the field or on the farm. In some cases, metals may also be introduced or their levels altered during processing, manufacturing, packaging or contact with materials and equipment. These contributions are generally more limited, but not

necessarily negligible. Unsuitable materials, inadequate processing conditions or particular production chains can affect the final levels of certain elements.

This does not mean that processed foods are necessarily more problematic. It simply means that food safety does not depend on a single step, but on the entire supply chain: the environment, cultivation, farming, harvesting, processing, storage and distribution.

PRESENCE DOES NOT AUTOMATICALLY MEAN RISK

One of the most important points to clarify is that detecting a metal in a food does not automatically demonstrate a real danger. Today, many elements can be detected at very low concentrations thanks to extremely sensitive analytical techniques. The right question is not simply “is it there or not?”, but “how much is present?”, “in what chemical form?”, “how often do we eat that food?” and “how much does it contribute to total exposure?”.

For this reason, health authorities set maximum levels for certain contaminants and carry out risk assessments based on exposure. However, as already noted in other areas of food safety, regulatory compliance does not always mean an absolute absence of risk: rather, it means that, based on available knowledge, that level is considered consistent with the degree of protection established by the legislation.

WHY DATA AND ANALYSIS MATTER

Because metals can reach food through multiple, often invisible pathways, we cannot assess a food simply by looking at it. A fish, a plate of rice or a vegetable may look perfectly normal and yet contain different concentrations of particular elements. Only analytical testing can measure what is actually present, replacing general impressions with objective data.

For consumers, this means that talking about metals in food should lead neither to indiscriminate alarm nor to false reassurance. The central point is to understand the pathways by which these substances may reach food, to know which foods deserve closer attention in relation to specific elements and to recognise the value of analysis and monitoring as tools for knowledge.

SCIENTIFIC AND REGULATORY REFERENCES

- [EFSA \(2009\). Scientific Opinion on Cadmium in Food.](#)
- [EFSA CONTAM Panel \(2009\). Scientific Opinion on Arsenic in Food.](#)

- [EFSA CONTAM Panel \(2012\). Scientific Opinion on Lead in Food.](#)
- [EFSA CONTAM Panel \(2012\). Scientific Opinion on the risk for public health related to the presence of mercury and methylmercury in food.](#)
- [Commission Regulation \(EU\) 2023/915 of 25 April 2023 on maximum levels for certain contaminants in food.](#)