

HOW TO INTERPRET PAH ANALYTICAL RESULTS

A laboratory report may contain very small values, often in micrograms per kilogram, alongside abbreviations such as LOQ or symbols such as '<'. These figures are not difficult to read, but require care: a result describes what was measured in a sample, not automatically an individual's habitual exposure or a comprehensive judgement about the safety of the food.

WHAT IS MEASURED?

Polycyclic aromatic hydrocarbons (PAHs) are investigated individually in food using validated instrumental methods. Reports should make clear which compounds were analysed, in which matrix, in what units and with what method performance. Analyses may cover many PAHs; for European maximum levels, benzo[a]pyrene and the sum of four indicators known as PAH4 are particularly important.

PAH4 comprises benzo[a]pyrene, benz[a]anthracene, benzo[b]fluoranthene and chrysene. This conventional indicator group does not equal the sum of all PAHs present and does not directly measure a mixture's overall toxicity.

UNITS OF MEASUREMENT AND COMPARABILITY

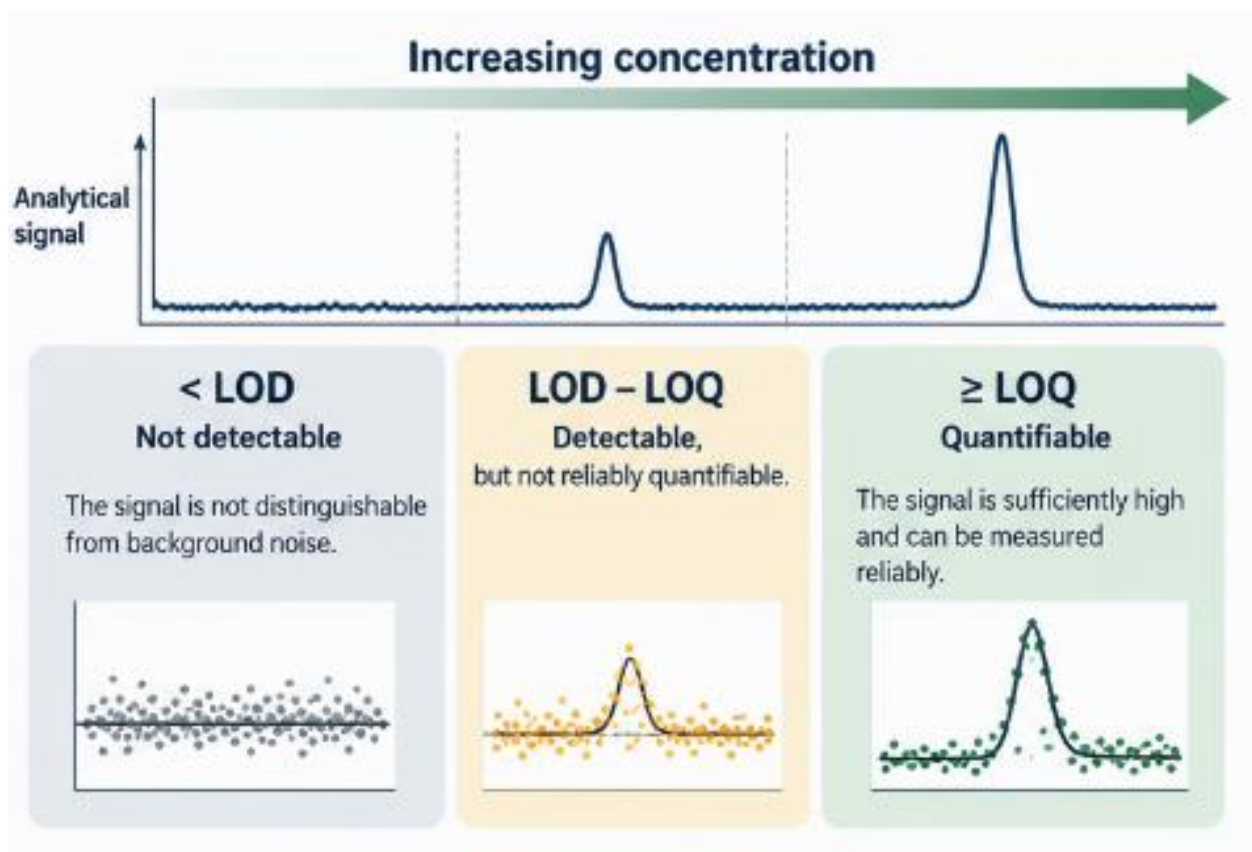
Concentrations are generally expressed in µg/kg (micrograms per kilogram): 1 µg/kg is one part per billion by mass, or 0.001 mg/kg. Comparing two results requires checking that they concern the same compound, the same units and equivalent analytical bases. Some limits, such as those for certain cocoa products, are expressed per kilogram of fat rather than per kilogram of product; confusing these bases can lead to incorrect conclusions.

The state of the product also matters: food as sold, edible portion, ingredient, dried product or reconstituted food may not be directly comparable. The report should clearly identify the sample.

LOD AND LOQ: DETECTION IS NOT QUANTIFICATION

The limit of detection (LOD) indicates the level at which a method can identify a substance's presence with adequate confidence; the limit of quantification (LOQ) is the lowest concentration the method can measure quantitatively with acceptable performance. Operational definitions depend on the method and applicable rules.

A result of '< 0.5 µg/kg' with an LOQ of 0.5 µg/kg means that the concentration was not quantified at that threshold. It does not mean that the substance is certainly absent. Nor are two laboratories reporting '< LOQ' necessarily equivalent: an LOQ of 0.1 µg/kg provides different information from one of 1.0 µg/kg.



HOW PAH4 IS CALCULATED WHEN A RESULT IS BELOW THE LOQ

For comparison with the maximum levels in Regulation (EU) 2023/915, PAH4 is calculated using the 'lower-bound' convention: components below their respective LOQs are assigned a value of zero in the sum. This is a regulatory calculation convention, not proof that the substances are absent.

Purely illustrative example, with all concentrations in µg/kg: benzo[a]pyrene 0.8; benz[a]anthracene 1.2; benzo[b]fluoranthene < 0.5; chrysene 0.9. The lower-bound PAH4 sum is $0.8 + 1.2 + 0 + 0.9 = 2.9$ µg/kg. Summing only quantified values nevertheless does not establish the exact true content of all four compounds.

Dietary exposure studies may also use 'middle-bound' and 'upper-bound' estimates, which handle values below the LOQ differently. These should not be confused with the convention prescribed for PAH4 maximum levels.

FROM A NUMBER TO LEGAL COMPLIANCE

Regulation (EU) 2023/915 sets separate maximum levels for benzo[a]pyrene and the PAH4 sum in particular food categories. There is no single limit applicable to all food. Before judging compliance, one must identify the correct product category, any

applicable conditions and notes, the basis on which the result is expressed and the current regulatory text.

A value below the applicable maximum level may indicate compliance for that parameter, but does not prove the absence of PAHs or guarantee that all possible contaminants were analysed. For some matrices, legislation specifies no PAH maximum level; inventing a legally binding limit by analogy would be incorrect.

MEASUREMENT UNCERTAINTY, RECOVERY AND OFFICIAL CONTROL

Every analytical measurement carries uncertainty. In official controls, Regulation (EC) No 333/2007 governs sampling and analysis for relevant contaminants including PAHs, and the consideration of measurement uncertainty and analytical recovery when assessing results. A measured value should therefore not be treated as mathematically exact.

For example, a result of 5.3 µg/kg with an expanded uncertainty of 1.0 µg/kg does not justify automatically rejecting a batch merely because it exceeds a hypothetical threshold of 5.0 µg/kg arithmetically. Official decisions follow specific rules accounting for uncertainty and other applicable requirements. The example does not represent a legal classification of any actual batch.

Sample representativeness is equally important. An accurate measurement of an unrepresentative sample does not necessarily describe the whole batch. The result for the portion analysed must therefore be distinguished from a conclusion about the entire lot.

CONCENTRATION, CONSUMPTION AND EXPOSURE

Health risk cannot be inferred from a single value in µg/kg. Assessing dietary exposure also requires the quantities consumed, consumption frequency, body weight and, when considering the entire diet, contributions from multiple foods. A relatively high concentration in an occasionally eaten food does not necessarily cause greater exposure than a lower concentration in a frequently eaten food.

For some genotoxic and carcinogenic substances, EFSA uses the Margin of Exposure (MOE) approach to identify risk-management priorities. The MOE is not a legal concentration limit and cannot properly be derived from a single analysis of an isolated food.

A CHECKLIST FOR READING A REPORT

Before interpreting a PAH result, check the identity and condition of the sample; the analyte list; units and expression basis; LOD and LOQ for each compound; method and its accreditation, where relevant; the criteria used to sum PAH4; uncertainty and

recovery, where applicable; and the correct food category and comparative legislation. Distinguish what has actually been measured from what has merely been estimated or inferred.

FROM COMPLIANCE TO UNDERSTANDING

Legislation and official controls play a fundamental role in protecting consumers and managing contaminants. A more informative reading of a report, however, goes beyond a simple 'compliant/non-compliant' label: it also considers individual analytes, method performance and the meaning of non-quantifiable results.

The most appropriate conclusion is always proportionate to the available evidence. An analysis describes one sample with a given degree of confidence; compliance concerns particular legal requirements; exposure and risk assessments require additional data. Keeping these three levels separate allows analytical chemistry to be used without turning it into either an absolute reassurance or a source of alarmism.

SCIENTIFIC AND REGULATORY REFERENCES

[EFSA CONTAM Panel \(2008\). Polycyclic Aromatic Hydrocarbons in Food. EFSA Journal, 724, 1–114.](#)

[European Commission. Regulation \(EU\) 2023/915 on maximum levels for certain contaminants in food, Annex I, Section 5.1 \(current version\).](#)

[European Commission. Regulation \(EC\) No 333/2007, methods of sampling and analysis for the control of contaminants in food \(consolidated text\).](#)

[European Commission. Legislative portal on contaminants in food.](#)