

OTHER VOLATILE ORGANIC COMPOUNDS RELEVANT TO FOOD

BTEX – benzene, toluene, ethylbenzene and xylenes – account for only some volatile organic compounds (VOCs). Other substances of possible relevance to food include solvents used in processing, compounds from food-contact materials and production environments, and contaminants originating in water or raw materials. Not all VOCs are undesirable: many are normal constituents of food aromas. Understanding a substance's origin is essential when interpreting its occurrence.

WHAT DOES 'OTHER VOC' MEAN?

The term VOC describes a physicochemical property: an organic substance's tendency to enter the gaseous phase under certain conditions. It does not identify one toxicological class or, in itself, imply hazard or contamination. Very different molecules may have comparable volatility yet entirely different origins, uses and risk profiles.

It is useful to distinguish three situations: substances produced naturally by food or fermentation; substances deliberately used in manufacturing, potentially subject to conditions of use and permitted residues; and contaminants introduced unintentionally through the environment, equipment, materials or improper processing practices. This is a functional rather than mutually exclusive classification: the same molecule, such as ethanol or acetone, may have different origins.



EXTRACTION SOLVENTS AND TECHNICALLY UNAVOIDABLE RESIDUES

Industrial processes may use solvents to separate components of raw materials. Hydrocarbon solvents, for example, can be used in oil extraction or ingredient processing, while others are used for decaffeination or obtaining flavourings. The solvent must subsequently be removed by the prescribed process, although a small residual quantity may be technically unavoidable.

Within the European Union, Directive 2009/32/EC governs authorised extraction solvents for food and food-ingredient production, specifying permitted uses and, where applicable, maximum residue limits. Its annex includes hexane, methyl acetate, methyl ethyl ketone, dichloromethane, methanol and propan-2-ol, among others; solvents such as ethanol, acetone and ethyl acetate instead appear in the section governing use in accordance with good manufacturing practice. The list has been updated over time, including the addition of 2-methyloxolane.

The meaning of these limits must not be generalised: a value established for one solvent, process or food category is not a limit for every VOC in every food. Product compliance must always be assessed against the applicable provision and matrix.

SOME EXAMPLES: HEXANE, ACETONE AND ALCOHOLS

In legislation, the commercial designation 'hexane' identifies a mixture of saturated hydrocarbons with specified characteristics, not necessarily pure n-hexane alone. Any residue in solvent-extracted products is consequently a matter of process control and compliance with authorised conditions. The mere statement 'solvent-extracted oil' does not justify assuming that dangerous solvent residues are present.

Acetone, ethanol and other alcohols may occur naturally, form during fermentation or processing, or be employed as processing aids subject to applicable rules. A single analytical measurement, without knowledge of the product and its processing history, may not reveal their source. For example, methanol occurring in some fermented drinks requires a different assessment from residual methanol used as an extraction solvent.

COMPOUNDS FROM PACKAGING AND CONTACT SURFACES

Plastics, adhesives, printing inks, coatings and production-line components may be sources of substances that migrate into food, including some relatively volatile ones. Actual transfer depends on material composition, the presence of functional barriers, temperature, contact time and food properties. Finding a substance in packaging is therefore insufficient to conclude that it has migrated into food.

Regulation (EC) No 1935/2004 lays down general requirements for food-contact materials, while Regulation (EC) No 2023/2006 governs good manufacturing practice.

Specific rules also apply to plastics, notably Regulation (EU) No 10/2011 and subsequent amendments. Migration limits belong to a different regulatory framework from extraction-solvent residue limits; confusing them would lead to incorrect assessments.

HALOGENATED VOLATILE ORGANIC COMPOUNDS: AN IMPORTANT DISTINCTION

Some VOCs contain chlorine or other halogens, including chlorinated solvents. They may arise from particular industrial uses or, for certain compounds, phenomena associated with water treatment. However, 'halogenated VOCs' do not correspond to the analytical parameter AOX, which measures adsorbable organically bound halogens collectively without identifying individual molecules.

Because Overorganic has a separate section on halogenated organic compounds, it is sufficient here to note that dichloromethane may have a regulated role as an extraction solvent for narrowly defined uses, whereas other organohalogen compounds are unintended contaminants. Their formation, persistence and measurement will be addressed in the dedicated section, avoiding unnecessary overlap.

COMPOUNDS FORMED DURING PROCESSING

Heating, lipid oxidation, fermentation and reactions between ingredients can generate volatile molecules including aldehydes, ketones, alcohols and organic acids. Some contribute positively to aroma; others may indicate rancidity or deterioration in quality. Their detection alone, however, does not establish that they are contaminants of health concern.

To interpret a result, the molecule must be identified, concentrations considered and compared with relevant evidence for the matrix, process and exposure. No single universal 'total VOC' value can indicate the safety of every food. Even a strong smell may result from minute amounts of compounds with low odour thresholds, without automatically indicating toxicological risk.

HOW TO INTERPRET AN ANALYTICAL RESULT

A reliable test report should specify the substances examined, the matrix, analytical technique and detection and quantification limits. Sampling and storage are especially important for volatile compounds: evaporative losses or accidental contamination during handling can distort results. Methodological details are examined in the analytical chapter.

'Not quantified' does not necessarily mean that a substance is entirely absent, but rather that its concentration is below the method's limit of quantification. Conversely, a measurable result does not automatically establish non-compliance or a health hazard. Interpretation requires any applicable legislation, appropriate toxicological information and a realistic estimate of exposure.

A USEFUL CONCLUSION

'Volatile organic compounds in food' covers very different phenomena. Residual solvents, substances migrating from materials, environmental contaminants and naturally generated molecules should not be treated as one problem. The decisive scientific step is to move beyond the broad category to the specific substance: how it formed, why it may be present in food, at what concentration and with what resulting exposure. Only then can food quality, regulatory compliance and health risk be properly distinguished.

SCIENTIFIC AND REGULATORY REFERENCES

European Union. Directive 2009/32/EC on extraction solvents – consolidated text as at 16 February 2023. [Source](#)

European Union. Regulation (EC) No 1935/2004 on materials and articles intended to come into contact with food. [Source](#)

European Commission. Regulation (EC) No 2023/2006 on good manufacturing practice for food-contact materials. [Source](#)

European Commission. Regulation (EU) No 10/2011 on plastic materials and articles intended to come into contact with food. [Source](#)