

6. CHLOROPROPANOLS AND OTHER CONTAMINANTS FORMED DURING FOOD PROCESSING

Not every chemical contaminant in food originates from polluted soil, water or industrial emissions. Some substances form unintentionally during the technological treatments required to produce food. Monochloropropanediols, particularly 3-MCPD and 2-MCPD, are important examples: they are chlorine-containing organic compounds studied especially in refined oils and certain processed ingredients.

WHAT ARE 3-MCPD AND 2-MCPD?

3-Monochloropropane-1,2-diol (3-MCPD) and 2-monochloropropane-1,3-diol (2-MCPD) are similar molecules, but the chlorine atom occupies a different position. They may occur in free form or be bound to fatty acids as esters. The distinction matters: esterified forms predominate in refined oils and fats, while free 3-MCPD has historically been studied, among other products, in acid-hydrolysed vegetable proteins.

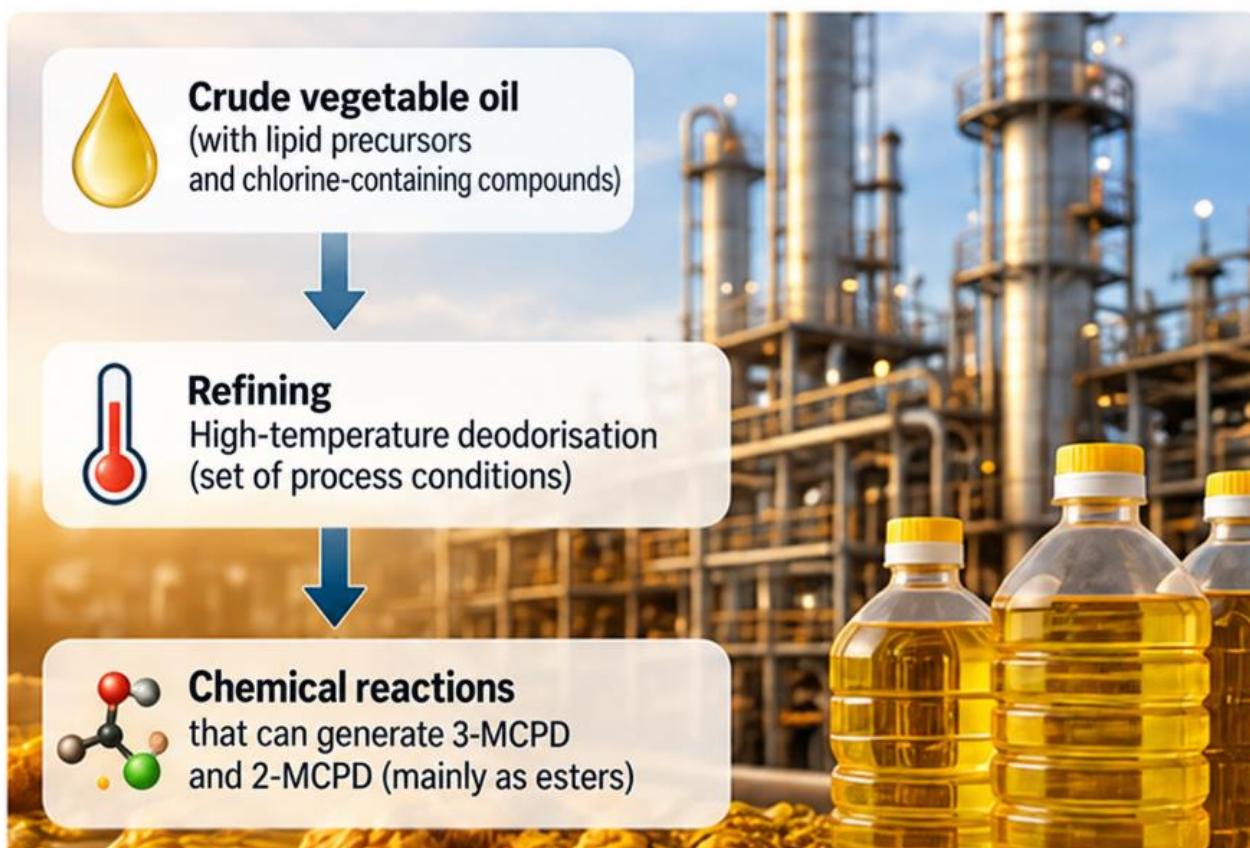
Chemical similarity does not imply identical toxicological properties. A relatively detailed risk assessment is available for 3-MCPD, whereas significant knowledge gaps for 2-MCPD prevent the establishment of a comparable tolerable daily intake.

HOW DO THEY FORM DURING REFINING?

During vegetable oil refining, particularly high-temperature deodorisation, certain precursors in raw materials can react to form MCPD esters. The availability of chlorine-containing compounds, lipid characteristics, crude oil quality and processing conditions are relevant. Temperature is important but is not a sufficient explanation on its own: formation depends on the combination of operating conditions and initial composition.

EFSA's 2016 investigations generally found higher concentrations in palm oil and palm fat than in the other oils and fats examined. This does not mean that every palm-containing product has high concentrations or that other refined oils are necessarily free of these substances. Raw materials, technology and mitigation measures can substantially affect the outcome.

How 3-MCPD and 2-MCPD form in refined oils



OTHER FORMATION ROUTES: HYDROLYSED VEGETABLE PROTEINS

Free 3-MCPD can also form during acid hydrolysis of vegetable proteins, where suitable conditions and lipid precursors are present. These ingredients may be used to add flavour to food preparations. Certain soy sauces, especially those produced by acid hydrolysis rather than traditional fermentation, have also been examined in monitoring programmes. A product's commercial name alone does not establish its 3-MCPD content.

WHERE MIGHT THEY OCCUR IN FOOD?

In addition to refined vegetable oils, exposure may arise from foods containing them, including bakery products, snacks, margarines and other processed foods. Infant formula and foods for young children merit particular attention because intakes relative to body weight can be comparatively high. Occurrence in an individual product must nevertheless be established by analysis: listing food categories identifies possible exposure pathways, not universal contamination.

GLYCIDYL ESTERS: AN ESSENTIAL DISTINCTION

Glycidyl fatty acid esters may form under similar technological conditions. They are assessed alongside MCPDs because some formation conditions and food matrices overlap. However, they are not halogenated organic compounds: glycidol contains no halogen atoms. They are mentioned here to clarify a scientific and regulatory distinction, not to assign them incorrectly to the chloropropanol family.

The distinction has toxicological consequences. For glycidyl esters, EFSA considers the potential release of glycidol, a genotoxic and carcinogenic substance. The 3-MCPD assessment focuses mainly on renal effects and male fertility outcomes observed in experimental studies. A single risk criterion cannot therefore be applied indiscriminately to all these contaminants.

WHAT DOES EFSA SAY ABOUT HEALTH EFFECTS?

In 2018, EFSA updated its assessment of 3-MCPD and its esters, establishing a group tolerable daily intake (TDI) of 2 micrograms per kilogram of body weight per day, expressed as 3-MCPD. EFSA's earlier 2016 value was 0.8 micrograms/kg body weight/day; citing that figure without the update would be misleading. The TDI is a toxicological reference point for sustained exposure, not a maximum permitted concentration in food.

In the reassessment, estimated exposure did not exceed the TDI in adults, but minor exceedances were possible in younger high-exposure groups and in certain scenarios involving exclusively formula-fed infants. This is not evidence of clinical harm to consumers; it indicates situations in which the protective margin warrants attention. Limited toxicological data for 2-MCPD make a comparable quantitative assessment difficult.

EUROPEAN MAXIMUM LEVELS: DO NOT CONFUSE THEM WITH THE TDI

Regulation (EU) 2023/915, as amended, sets maximum levels for specified food categories. For free 3-MCPD in hydrolysed vegetable protein and soy sauce, the prescribed level is 20 micrograms/kg, referred to a liquid product containing 40% dry matter, subject to the qualifications in the Annex. Oils, fats and certain foods for infants and young children are instead subject to provisions on the sum of 3-MCPD and its esters, expressed as 3-MCPD; the values differ by category.

The consolidated regulation available in October 2026 also provides for certain reductions in maximum levels from 1 January 2027. Those future levels must not be presented as already applicable. Maximum levels for glycidyl esters are also distinct

from those for 3-MCPD. Compliance assessment must always verify the exact product category, application date and version of the regulation in force.

HOW IS AN ANALYSIS PERFORMED AND INTERPRETED?

Depending on the purpose of the test, analysis must distinguish free 3-MCPD from the sum of 3-MCPD and its esters. Laboratories use validated methods, often involving sample preparation, controlled conversion of esterified forms and chromatography with selective detection. Preparation is particularly delicate because transformations or interference may distort the measurement.

At least four details matter in a test report: the substance or sum measured, units, limit of quantification (LOQ) and food matrix. A 'below LOQ' result does not establish absolute absence; a quantifiable concentration does not automatically imply health risk or legal non-compliance. Compliance is assessed against the level applicable to the category, while health risk also depends on overall exposure and consumption frequency.

REDUCING FORMATION WITHOUT OVERSIMPLIFICATION

Prevention is mainly a supply-chain and processing task: selecting and treating raw materials, controlling precursors, optimising refining conditions and using technological mitigation strategies. These measures involve industrial trade-offs and must preserve oil safety, stability and quality. The issue should not be reduced to a simplistic contrast between 'industrial' and 'natural' food. What matters is actual contamination, which can be measured analytically.

CONCLUSION

Chloropropanols illustrate contamination arising not from environmental pollution but from unintended chemical reactions during food processing. Their assessment requires distinguishing 3-MCPD from 2-MCPD, free compounds from esters, and measured levels from toxicological reference values. European rules and technological research help reduce exposure, while sampling quality, process control and proper interpretation of analytical results remain important.

SCIENTIFIC AND REGULATORY REFERENCES

[1. EFSA CONTAM Panel \(2016\). Risks for human health related to the presence of 3- and 2-MCPD and their fatty acid esters, and glycidyl fatty acid esters in food. EFSA Journal, 14\(5\), 4426.](#)

- [2. EFSA CONTAM Panel \(2018\). Update of the risk assessment on 3-monochloropropane diol and its fatty acid esters. EFSA Journal, 16\(1\), 5083.](#)
- [3. EFSA \(2018\). Revised safe intake for 3-MCPD in vegetable oils and food.](#)
- [4. European Commission. Regulation \(EU\) 2023/915 on maximum levels for certain contaminants in food, consolidated text \(19 August 2026\), Annex I, sections 5.2–5.4.](#)