

The Safety Process Has Two Ledgers

Europe's 2026 Infant-Food Contaminant Reform and the Missing Link Between Microbial Protection, Chemical Formation and Ingredient Sourcing

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ORIGINAL ENGLISH EDITION

ABSTRACT

The European Union's July 2026 amendments to its food-contaminant framework create two approaching compliance milestones for infant and young-child foods: new or tighter limits for 3-monochloropropanediol and glycidyl esters from January 2027, and the first EU maximum levels for a weighted sum of furan and two methylfurans from January 2028. Their significance extends beyond numerical limits. The contaminants arise through different manufacturing pathways—principally upstream oil refining for certain fatty-acid esters and thermal processing for furans—while the same finished food must also satisfy uncompromised microbiological safety, nutritional and shelf-life requirements. Recent analytical and pilot-scale studies reveal substantial opportunities for mitigation, but also matrix effects, scale-up failures and differences between concentrations measured in sealed products and exposure after preparation. This article proposes a dual-ledger process-validation approach linking ingredient provenance, microbial lethality, contaminant formation, analytical uncertainty and jurisdiction-specific legal status. It distinguishes binding law from scientific hypotheses and explains why neither reduced heating nor a compliant supplier certificate is, alone, a sufficient infant-food safety strategy.

KEYWORDS: *infant food; furan; methylfurans; 3-MCPD; glycidyl esters; thermal processing; contaminant mitigation; regulatory compliance*

1 | A regulatory event with two clocks

On 29 July 2026, the European Commission adopted two amendments to Regulation (EU) 2023/915 on maximum levels for certain contaminants in food. Regulation (EU) 2026/1825 revised provisions for 3-monochloropropanediol (3-MCPD), its fatty-acid esters and glycidyl fatty-acid esters. Regulation (EU) 2026/1890 established maximum levels for the sum of furan, 2-methylfuran and 3-methylfuran in specified infant and young-child foods. Both appeared in the Official Journal on 30 July and entered into force on 19 August 2026. Their relevant future application dates are different: 1 January 2027 for specified new and reduced 3-MCPD/glycidyl limits, and 1 January 2028 for the new furan-group limits. [1–3]

This is not a general ban on heated foods or refined oils. It is a set of category-specific maximum levels, measurement conventions and transitional provisions. Nor should the dates be conflated: certain revised oil and compound-food provisions in the 3-MCPD/glycidyl amendment operate from entry into force, while the explicitly identified infant-food provisions have the 2027 date. A regulatory dossier must map the exact Annex entry and date rather than attach one blanket implementation date to the entire regulation. [1,2]

The deeper event is scientific. Food processors have long validated heat treatment for microbiological control and shelf life. They must now integrate a second ledger: the chemical consequences of sourcing and processing, including compounds whose formation may be promoted by the same thermal conditions that protect against biological hazards.

2 | The two ledgers are connected, but not identical

The first ledger records whether a product is microbiologically safe: relevant pathogens and spores, product pH and water activity, scheduled thermal process, container integrity, post-process contamination, distribution conditions and validated shelf life. The second records whether the process and its inputs produce an acceptable chemical burden: contaminant precursors, formation and removal kinetics, partitioning, analytical results and dietary exposure.

The ledgers must be read together, but it would be chemically incorrect to imply that one retort cycle is responsible for every contaminant addressed in the July 2026 amendments. Furans can form during heating of the final food, particularly in sealed or otherwise retention-favouring systems. By contrast, substantial 3-MCPD ester and glycidyl ester burdens may already be present in refined oils before those oils reach the baby-food plant. Further product processing and matrix effects still matter, but upstream oil manufacture is a major intervention point. [4–7]

A lower furan result obtained by weakening a validated kill step would be an unacceptable trade. Equally, an excellent microbial process cannot excuse a finished product above a legally applicable contaminant maximum. Safety is the intersection of constraints, not a competition in which one endpoint is allowed to compensate for another.

3 | The furan rule: three analytes, one legal calculation

Regulation (EU) 2026/1890 inserts entry 5.6 into Annex I of Regulation (EU) 2023/915. For the specified categories, the legal sum is expressed as furan and calculated as:

$$C(\text{total, as furan}) = C(\text{furan}) + 0.83 \times C(2\text{-methylfuran}) + 0.83 \times C(3\text{-methylfuran}).$$

The maximum levels are 40 micrograms per kilogram for processed cereal-based food for infants and young children; 30 micrograms per kilogram for dairy-based or fruit-based baby food, or mixtures of dairy and fruit, where these constituents represent at least 80% of the product; and 80 micrograms per kilogram for other baby food. The legal sum uses a lower-bound convention: analytical results below the limit of quantification are treated as zero in the calculation. The Regulation applies from 1 January 2028. [2]

The coefficient 0.83 is not an analytical recovery correction, a toxicological safety factor invented by the manufacturer or an optional commercial convention. It is part of the legal expression of the methylfurans as furan. Importantly, the limits do not apply automatically to every food marketed to children, every infant formula, or every product containing fruit: the legal category definitions and composition thresholds must be checked first.

4 | A worked calculation and its limits

Consider an illustrative cereal-based infant food with measured concentrations of 21 micrograms per kilogram furan, 12 micrograms per kilogram 2-methylfuran and 6 micrograms per kilogram 3-methylfuran. Its calculated sum is $21 + (0.83 \times 12) + (0.83 \times 6) = 35.94$ micrograms per kilogram. If the product belongs to the 40-microgram category, the arithmetic result is below that numerical maximum.

This is a hypothetical teaching example, not a test result, compliance certificate or finding about any commercial food. In practice, category classification, representative sampling, analytical uncertainty, the applicable method, results below quantification limits, lot heterogeneity and the product as placed on the market all matter. A company should not design its release specification exactly at the statutory ceiling without considering variability and uncertainty. The numerical buffer is a risk-management choice to validate, not a separate legal limit.

A particularly important distinction concerns preparation. A jar sampled immediately after opening may have a different volatile-furan concentration from food transferred, reheated and stirred before consumption. The legal concentration and the consumer's ingested concentration are related but not identical analytical objects. Manufacturers should not assume that expected domestic volatilisation can replace compliance with the legal maximum as marketed. [2,8,9]

5 | The 2027 oil and baby-food limits

Regulation (EU) 2026/1825 introduces, from 1 January 2027, maximum levels for baby food and processed cereal-based food for infants and young children of 50 micrograms per kilogram for the sum of 3-MCPD and its fatty-acid esters, expressed as 3-MCPD, and 25 micrograms per kilogram for glycidyl fatty-acid esters, expressed as glycidol. The maxima apply to the product as placed on the market. [1]

For vegetable oils and fats, fish oils and oils from other marine organisms destined for manufacturing these foods, the relevant 3-MCPD maximum decreases from 750 to 500 micrograms per kilogram and the glycidyl-ester maximum from 500 to 250 micrograms per kilogram, also from 1 January 2027. These ingredient limits do not displace the separate finished-

food limits. The amendment additionally specifies rules for general oils, certain composite foods with more than 5% fat, mixtures and different product presentations; these must be read on their own terms. [1]

The commercial implication is that a supplier's compliant oil is necessary but not sufficient. The finished food must comply under its own category. Conversely, an end-product test alone does not show that the incoming oil specification or change-control system is robust. These are different control points in the same material genealogy.

6 | Do not confuse infant formula with complementary foods

The revised Annex distinguishes infant formulae, follow-on formulae, foods for special medical purposes for infants and young children, and young-child formulae from the categories of baby food and processed cereal-based food. Existing separate 3-MCPD and glycidyl-ester limits for formula products are expressed according to whether they are marketed as powders or liquids. They must not be replaced by the 50/25 microgram figures intended for the new complementary-food entries. [1]

Likewise, the 2028 furan entry addresses specified processed cereal-based foods and baby foods, not a universal infant-nutrition category. The legal taxonomy is not a semantic inconvenience: it determines the applicable maximum, the presentation basis and the compliance evidence. In mixed portfolios, a master specification that treats every product as 'baby nutrition' can be dangerously imprecise.

This is an area where regulatory and technical functions must work together. A formulation change can move a product across a category boundary, while an unchanged manufacturing line may make multiple categories. A controlled classification record should therefore sit beside each recipe and finished-product specification.

7 | The chemistry of furan is not reducible to temperature

EFSA's 2017 opinion identifies several possible furan precursors, including ascorbic acid, amino acids, carbohydrates, unsaturated fatty acids and carotenoids. Furan and methylfurans can form through multiple thermal pathways; the resulting concentrations depend on matrix composition, time-temperature history, oxygen, headspace, packaging, storage and the potential for volatile compounds to escape. The critical toxicological concern in EFSA's assessment included liver injury and carcinogenic effects in animal studies, with infants among the higher-exposure groups. [4,5]

The chemistry is therefore not governed by a universal equation such as 'five degrees cooler equals a fixed percentage less furan'. Carotenoid-rich vegetable purees may behave differently from cereal porridges, fruit preparations or meat-and-vegetable meals. The relative formation of 2-methylfuran and 3-methylfuran can also differ from that of furan itself. A process change that lowers one analyte may not lower the weighted sum proportionately. [10,11]

This complexity has a constructive consequence. Rather than selecting a single contaminant surrogate, process-development studies should measure all three legally relevant analytes and, when justified, broader untargeted reaction products. A mitigation claim needs a defined matrix and scale.

8 | What recent studies actually demonstrate

A 2025 Food Chemistry study examining 89 commercial baby-food samples reported elevated furan in certain ready-to-eat meals and vegetable purees, with measured values in those categories spanning 12–118 micrograms per kilogram. The authors also observed meaningful effects of raw materials, vegetable varieties, storage and reheating. These are occurrence data from sampled products, not a declaration that any particular item breaches the 2028 legal limits. The study predated their application and measured a wider panel of compounds. [10]

A Food Research International investigation of high-pressure thermal processing in vegetable-and-meat infant meals found substantial furan reductions in laboratory-scale material, but the results were less consistent at pilot scale; notably, 3-methylfuran was not significantly reduced by the treatment alone in the pilot-scale experiment. Longer preheating was identified as a plausible explanation for the scale effect. Additional home-reheating and stirring steps further changed measured levels. [11]

The important lesson is not that high-pressure thermal processing has solved furan. It is that a favourable bench-scale result may fail to transfer directly to a production-size package. Product geometry, heating and cooling trajectories, preheating duration and volatile mass transfer are not peripheral engineering details; they are part of the contaminant mechanism.

9 | Why sealed-package testing is a special analytical problem

Furan is volatile. The act of opening, homogenising or warming a sample can change the concentration subsequently measured. FDA's analytical method emphasises chilling samples, rapid handling and prompt transfer to sealed headspace vials to limit analyte loss. Modern gas-chromatography/mass-spectrometry methods, including headspace and solid-phase microextraction approaches, can target furan and methylfurans, but method suitability must be established for each relevant matrix. [8,12,13]

A defensible analytical plan should identify sampling point, unopened-container handling, transport temperature, homogenisation, headspace conditions, calibration approach, isotopically labelled internal standards where appropriate, matrix recovery, measurement uncertainty and analyte-specific quantification limits. It should explicitly preserve the lower-bound legal calculation rather than substitute a different treatment of censored values without explanation.

One underappreciated failure mode is a technically accurate laboratory result for the wrong analytical state. A jar opened and left exposed before aliquoting may underrepresent the as-marketed volatile burden. Conversely, a sealed-jar concentration should not be casually equated with the dose after household preparation. Both questions are legitimate, but they serve different purposes.

10 | 3-MCPD esters and glycidyl esters are a different chemical problem

3-MCPD and its esters are associated with certain food-processing conditions, notably oil refining, while glycidyl esters can form under elevated-temperature deodorisation conditions in refined oils. Their formation depends on precursor chemistry, refining history and the oil matrix. They cannot be reliably managed by testing furan in the finished puree, nor should a thermal intervention designed for the puree be presumed to correct contamination already present in a purchased oil. [6,7,14]

EFSA revised its tolerable daily intake for 3-MCPD and its fatty-acid esters to 2 micrograms per kilogram body weight per day in 2018, while maintaining its separate concern about genotoxic and carcinogenic glycidyl esters. These toxicological concepts are not interchangeable with statutory maximum levels expressed in micrograms per kilogram of food. The first is a risk-assessment reference for intake; the second is a legally enforceable concentration criterion in a defined food category. [6]

For the manufacturer, the high-leverage questions are often upstream: which oils are used, how were they refined, what is their validated contaminant profile, how variable are suppliers and lots, and what happens when the fat composition of the final product changes?

11 | Ingredient specifications need a formulation-level mass balance

A simple screening mass balance can estimate how an ingredient contaminant may contribute to a finished food. If an oil is used at mass fraction w and contains contaminant concentration $C(\text{oil})$, the nominal contribution is $w \times C(\text{oil})$, before accounting for any formation, removal, concentration or matrix effects during further manufacture. The model is not a substitute for finished-product analysis or the applicable legal calculation.

For example, an oil containing 200 micrograms per kilogram of glycidyl esters, expressed as glycidol, used at 5% by mass would nominally contribute 10 micrograms per kilogram of final food, assuming no subsequent change. This hypothetical arithmetic neither certifies the oil nor guarantees that the finished product will meet its category limit. Other inputs, analytical basis, process changes and formulation variability remain relevant.

The practical benefit is to establish an ingredient contaminant budget before pilot manufacture. Such a budget can guide procurement and formulation, but it should be calibrated with measured production lots. For mixed oils, the revised EU Annex also contains specific mixture rules and, in some situations, fat-basis maximum levels. An internal spreadsheet cannot override the regulatory text. [1]

12 | Microbial lethality is a hard constraint, not a negotiable variable

A process developer seeking lower furan might shorten heating, change the temperature profile, adjust container geometry, adopt aseptic filling or explore high-pressure thermal treatment. Each change must be assessed against the relevant biological hazards and process validation requirements. Low-acid shelf-stable foods present a different microbiological challenge from acidified or refrigerated products; product pH, water activity, heat penetration and post-process contamination all influence the required control strategy.

It is therefore unsound to compare chemical-contaminant results from two heat processes without establishing that both deliver an appropriate and validated microbiological safety outcome for the same product and distribution scenario. The

relevant design space is not the lowest furan concentration attainable at any cost. It is the set of processes that simultaneously satisfy microbiological safety, legal chemical limits, nutritional integrity, sensory acceptability and feasible shelf life.

The same principle applies to non-thermal or combined technologies. A technology described as 'mild' is not inherently equivalent to a validated commercial-sterility process. Product-specific challenge studies, thermal-distribution studies, equipment qualification and applicable legal requirements remain essential.

13 | The two clocks create a procurement problem before a processing problem

The 2027 milestone is close enough to affect current oil tenders, supplier audits and formula approval. Manufacturers should not wait for 2027 to ask whether their 2026 supplier certificates report 3-MCPD and glycidyl esters using the relevant expression, matrix, quantification basis and frequency. A certificate may report only a generic contaminant panel or may omit whether the results concern the oil as supplied.

The 2028 furan milestone creates a different workstream: process and packaging trials, method qualification, baseline mapping across product categories and realistic scale-up. These workstreams overlap through formulation, because oils, carbohydrates, proteins and micronutrients can alter thermal reaction chemistry. Yet the intervention points are not the same. [1,2,10,11]

A staged programme should begin with category classification and baseline testing, then introduce source controls, process design of experiments and final validation. It should avoid locking in a reformulation based solely on one contaminant if that reformulation compromises nutrition, allergen management or microbial stability.

14 | The legal transition is not an exemption from general safety law

Both July regulations provide transitional treatment for foods lawfully placed on the market before the relevant application dates, allowing them to remain until their date of minimum durability or use-by date, subject to the precise amended Article 10 provisions. That is not permission to newly place non-compliant foods on the market after the applicable date, nor a safe harbour for foods that are otherwise unsafe under general food law. [1–3]

Regulation (EC) No 178/2002 continues to impose general food-safety and traceability obligations. Regulation (EC) No 853/2004 and relevant sector-specific rules govern hygiene and food-business controls. Regulation (EU) 2023/915 generally prohibits placing foods above the applicable contaminant maximum on the market and contains rules for processing, drying, dilution and compound foods. The legal analysis must identify the specific food, stage and applicable Annex entry. [3,15,16]

For Spain, these EU regulations are directly applicable. The competent official-control arrangements involve the relevant Spanish authorities within the EU food-control framework; EFSA performs scientific risk assessment but does not issue a company-specific certificate of compliance. Legal conformity remains an operator responsibility supported by official controls.

15 | Great Britain and Northern Ireland: a moving alignment question

It would be incorrect in October 2026 to state that the July EU contaminant amendments automatically became domestic Great Britain law merely upon EU publication. Great Britain operates its own applicable legal framework, including assimilated legislation, while Northern Ireland has different EU-linked arrangements under the Windsor Framework. Export dossiers must therefore distinguish destination territory, product type and route to market. [17,18]

The forward-looking picture is more complex than simple divergence. UK Government guidance updated on 30 July 2026 describes a proposed UK–EU sanitary and phytosanitary agreement, intended to take effect in mid-2027, under which Great Britain would align with specified EU food rules, including contaminant requirements. The guidance expressly says negotiations and details remain unresolved. A planned alignment date is not a currently binding legal instrument. [17]

The prudent strategy is dual tracking: verify present Great Britain requirements separately, prepare technically for the likely EU-aligned specification where commercially rational, and maintain versioned legal assumptions until the final UK implementing position is known. Northern Ireland movement schemes and eligible retail routes require their own assessment rather than an undifferentiated 'UK' statement. [17,18]

16 | United States: hazard control without the same EU numerical framework

The US Food and Drug Administration recognises furan as a process contaminant associated with heat treatment, including jarred and canned foods, and has published analytical methods and occurrence information. The US approach

cannot be described simply as identical to the EU's new 2028 category-specific weighted-sum limits. FDA's public furan materials focus on scientific monitoring and risk evaluation; a US compliance dossier should not import the EU 30/40/80 microgram limits as if they were automatically US federal maximums. [8,12]

Manufacturers must instead evaluate the applicable US food-safety, adulteration, preventive-controls and product-specific requirements, alongside any relevant state obligations and contractual customer specifications. A multinational supplier may rationally choose an internal contaminant specification suitable for several markets, but such a specification should be identified as company policy rather than misrepresented as a uniform statutory threshold.

The broader comparison reveals a useful asymmetry: a quantified EU limit can accelerate method validation and procurement controls, while a jurisdiction without an identical numerical limit still requires defensible safety decisions. Absence of the same number is not evidence of absence of the hazard.

17 | The lower-bound convention can hide an analytical design problem

The furan amendment explicitly requires a lower-bound calculation, treating results below the quantification limit as zero. This provides a defined legal method for summation, but it does not mean a laboratory may select insensitive quantification limits without consequence. If the method's LOQ is high relative to the category maximum, uncertainty about actual concentrations may become operationally material. [2]

Suppose two laboratories analyse the same heterogeneous puree and one reports an analyte below 1 microgram per kilogram while the other reports it below 10. Both may express a non-quantified result, but they have not supplied equivalent information about the possible contribution of that analyte. Legal lower-bound arithmetic and the fitness of the analytical method are distinct questions.

A robust supplier or finished-product specification should therefore state individual analyte LOQs, recovery and uncertainty, rather than only the calculated weighted sum. Internal decision limits should consider sampling variability and method performance. This is a technical governance recommendation, not a new legal conversion rule.

18 | Mitigation may move the problem instead of eliminating it

Furan can be reduced through changes to precursor composition, thermal history, package geometry and volatile release; 3-MCPD and glycidyl esters can be mitigated through upstream refining choices and contaminant-control steps. Yet interventions have side effects. An ingredient substitution can change fat-soluble nutrient delivery or oxidation stability. An altered heat cycle can affect microbiological lethality and texture. More aggressive volatile stripping can alter aroma. Additional processing can increase energy and water use. [7,10,11,14]

The strongest process claim is therefore not 'contaminant reduced' but 'contaminant reduced under a defined and validated set of safety, quality and resource constraints'. It should report absolute starting and ending concentrations, not only impressive percentage reductions. A 90% decrease from a very high starting concentration may still leave a product above its applicable maximum; a smaller decrease in a different matrix may be entirely sufficient.

Nor should results from one analyte be extended to a chemical family without measurement. Pilot-scale evidence that furan decreases while 3-methylfuran does not significantly change is precisely why the new EU weighted-sum rule deserves analyte-specific process science. [2,11]

19 | Research & Innovation Opportunity

UNRESOLVED PROBLEM. Microbial process validation, chemical-contaminant monitoring, ingredient procurement and regulatory category decisions are commonly managed through different datasets. The resulting dossier may not explain whether a formulation or process change improves total product safety or merely shifts risk between endpoints.

WHY IT MATTERS. The 2027 and 2028 EU limits create an unusually clear test case: incoming refined oils can carry ester contaminants, while later heat treatment can form volatile furans. Both pathways feed into a product whose microbiological protection is non-negotiable.

WHAT IS ALREADY KNOWN. EU maximum levels and their dates are established; EFSA has assessed furan and 3-MCPD hazards; analytical methods and published mitigation studies exist; and scale-dependent furan behaviour has been demonstrated. These are not inventions of this article. [1–14]

WHAT REMAINS UNKNOWN. No generally validated, transferable model currently demonstrates how to predict the combined microbial, furan-group, 3-MCPD/glycidyl, quality and resource outcomes of an ingredient-and-process change across diverse infant-food matrices and manufacturing scales.

PROPOSED HYPOTHESIS. A Dual-Ledger Process Evidence Model (DLPEM)—a version-controlled framework connecting raw-material contaminant budgets, validated microbial controls, measured formation and removal kinetics, analytical uncertainty, product categories and market-specific legal dates—could identify safer feasible formulations and processing windows more reliably than isolated contaminant or lethality optimisation.

DEVELOPMENT PATHWAY. Build paired datasets for representative cereal, fruit/dairy and vegetable-meal matrices. Record oil genealogy, relevant precursors, package format, heat penetration and cooling, microbial validation, furan/2-methylfuran/3-methylfuran, 3-MCPD and glycidyl esters, nutrient retention, sensory quality and resource inputs. Link each observation to a recipe version, equipment configuration, lot and dated legal classification.

KEY VALIDATION STEPS. Use blinded, multi-site and multi-scale replication; validated matrix-specific analytical methods; independent microbial challenge or equivalent product-appropriate validation; prospective prediction of the legally weighted furan sum; and comparison against conventional separate-workstream decisions. Report false-safe predictions, uncertainty and negative results. Assess whether the model adds value beyond simpler procurement and process controls.

REGULATORY CONSTRAINTS. DLPEM would be a research and decision-support proposal, not an official approval system. It cannot replace statutory limits, scheduled-process validation, official controls or product-specific legal review. It must never trade reduced microbial safety for lower chemical contaminants.

POTENTIAL INDUSTRIAL RELEVANCE. If validated, the model could support ingredient supplier qualification, reformulation, process scale-up, packaging decisions, export compliance and evidence-based customer declarations without disclosing confidential process recipes.

20 | A falsifiable industrial study

A credible research agenda must allow the possibility that its added complexity is unnecessary. One study could compare three decision pathways for matched product families: conventional HACCP plus supplier COAs; the same approach supplemented with targeted contaminant budgets; and the full DLPEM integrating microbial, chemical, formulation, package and legal data. All arms would have to satisfy minimum legal and microbiological requirements before comparison.

The primary endpoint could be the proportion of production-scale lots meeting all applicable contaminant specifications while retaining independently validated microbiological safety and declared nutritional quality. Secondary endpoints could include chemical concentration variance, supplier requalification frequency, analytical cost, process energy, product waste, sensory acceptance and the time needed to resolve regulatory queries.

If the integrated model performs no better than well-designed simpler controls, its use should be limited or abandoned. If it improves outcomes, the improvement should be quantified and independently replicated. The proposed study is an editorial research concept, not a claim that INTABIOTECH or another organisation has already validated it.

21 | What ingredient suppliers should change now

A serious supplier qualification programme should connect the commercial specification to the contaminant pathway. For fats and oils, that means identifying the correct food category, refining and supplier controls, batch variation, 3-MCPD/glycidyl results and change notification. For fruit, vegetable and cereal ingredients, it means documenting relevant composition and precursor variability where it materially influences furan formation during the customer's process.

The objective is not to demand every proprietary process detail from every manufacturer. Controlled declarations, agreed analytical methods, independently verified quality systems and confidential regulatory disclosures can preserve industrial know-how. What matters is whether the safety conclusion is traceable and sufficiently specific for the intended application.

For INTABIOTECH-relevant areas -food preservation, functional ingredients, mineral technologies and industrial formulation- the opportunity lies in analytical specification design, matrix-aware process studies and cross-jurisdictional dossier architecture. No claim is made that any particular ingredient mitigates these contaminants without product-specific evidence. A mineral additive or antioxidant should not be promoted as a furan or 3-MCPD solution solely because a mechanistic hypothesis sounds plausible.

22 | An implementation protocol for manufacturers

First, classify each product under the precise EU Annex entry and record the date of application. Second, inventory all relevant fats, oils and precursor-bearing ingredients, with supplier-specific analytical evidence. Third, establish baseline

finished-product concentrations for the legally relevant analytes using a fit-for-purpose sampling and analytical plan. Fourth, map validated microbial safety requirements and identify which process variables may legitimately be changed. Fifth, conduct designed trials that measure both chemical and microbiological endpoints, followed by scale-up confirmation.

Sixth, set internal release criteria with defensible margins for variability and uncertainty, without disguising internal limits as statutory maxima. Seventh, implement supplier and process change control linked to recipe, equipment, packaging and legal versions. Eighth, prepare market-specific evidence for the EU and Spain, Great Britain, Northern Ireland and the United States, with explicit recognition of the unresolved UK alignment timetable.

The purpose of this protocol is not to add paperwork for its own sake. It is to make every safety-relevant decision reproducible: why an ingredient was selected, why a thermal process is adequate, why a chemical limit is met, and which changes would trigger revalidation.

23 | Evidence status and editorial limitations

ESTABLISHED EVIDENCE. Regulations (EU) 2026/1825 and 2026/1890 set the specified maximum levels and future dates; EFSA has assessed the relevant chemical hazards; furan forms in heat-treated foods; and refined oils can contain 3-MCPD and glycidyl esters. [1–7]

EMERGING EVIDENCE. Recent matrix-specific and pilot-scale studies support certain mitigation routes, but performance varies by analyte, matrix and scale. A single promising study cannot establish general industrial efficacy. [10,11]

EXPERT INTERPRETATION. The combination of the two 2026 amendments makes integrated ingredient-and-process evidence strategically valuable, especially for manufacturers with multi-market infant-food portfolios. This is an analytical interpretation, not an official Commission or EFSA policy statement.

HYPOTHESES. Linked contaminant budgets and microbial–chemical process data may improve process-window selection and reduce avoidable testing or reformulation. This has not been demonstrated as a universal result.

PROPOSED RESEARCH. DLPEM is an editorial R&D proposal. No standard, commercial product, validated algorithm, patentability or proprietary experiment is asserted. Legal positions are assessed against sources available on 20 October 2026 and may change, particularly in Great Britain.

24 | Conclusions: a safe process is a feasible region

The 2026 European reforms are often presented as new numbers on a contaminant table. Their industrial importance is more profound. They require manufacturers to recognise that a finished food can acquire different chemical burdens at different points in its life: during upstream oil refining, during formulation and during thermal preservation. Each burden must be assessed without compromising microbiological protection.

The 2027 and 2028 deadlines offer an opportunity to redesign evidence rather than merely expand testing. The most defensible system links ingredient provenance, legal category, process lethality, chemical formation, analytical quality, finished-product exposure and change control. It recognises that a lower contaminant result is not automatically a safer food if the process has weakened a critical biological barrier.

The durable principle is straightforward: microbial safety is a hard boundary; chemical limits are hard boundaries; and innovation belongs in the validated space between them.

Related Knowledge Areas

- Food Safety - process contaminants, microbial lethality, exposure and analytical uncertainty.
- Processing Technologies - thermal design, high-pressure thermal processing, packaging and scale-up.
- Functional Ingredients - oil specifications, formulation and precursor management.
- Regulatory Affairs - EU/Spain implementation, Great Britain alignment, Northern Ireland and US distinctions.
- AI & Food - evidence-linked digital process validation and change-impact assessment.
- Sustainability - mitigation trade-offs, energy, waste and recovery-adjusted performance.
- Emerging Research - dual-ledger optimisation and prospective multi-site validation.

Editorial Scope & Evidence Note

This article is an original scientific, regulatory and industrial analysis based on primary legal texts, public institutional sources and published research available by 20 October 2026. It does not constitute an EFSA or European Commission opinion, legal advice on a particular product, a validation of a named technology or a claim of patentable novelty. Numerical worked examples are explicitly hypothetical. Product-specific legal classifications and current consolidated legislation must be checked before commercial decisions.

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