A Recycled-Content Claim Is Not a Food-Contact Safety Case

Europe's 2026 mass-balance accounting rules, beverage-bottle obligations and the unresolved evidence boundary between circularity and chemical safety

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Abstract

The European Union's 2026 packaging transition creates a consequential distinction for beverage manufacturers: the amount of recycled plastic attributed to a bottle is not, by itself, evidence that the material is safe for food contact. Commission Implementing Decision (EU) 2026/1425, published on 3 July 2026, revises the methodology for calculating, verifying and reporting recycled content in single-use plastic beverage bottles, including accounting for recycling routes beyond conventional mechanical PET recycling. At the same time, Regulation (EU) 2022/1616 and the broader food-contact framework retain independent requirements concerning feedstock control, decontamination, migration and traceability. This article examines the resulting interface among mass balance, physical composition, chemical risk and industrial procurement. It compares European obligations with the more fragmented approaches in Great Britain and the United States, and proposes a testable dual-evidence qualification model for packaging specifications. The model is a research agenda, not an authorised certification scheme. The principal conclusion is that circular-content accounting and consumer-safety substantiation must remain distinct, connected and auditable.

Keywords: recycled PET; mass balance; food-contact materials; beverage bottles; chemical recycling; migration; packaging regulation; traceability

1 | The 2026 signal: two questions that law does not collapse

The EU's packaging regime reached a significant operational milestone in 2026. Regulation (EU) 2025/40 on packaging and packaging waste became generally applicable on 12 August 2026, subject to its differentiated provisions and transitional dates. Separately, Commission Implementing Decision (EU) 2026/1425 of 30 June 2026 was published on 3 July and replaced Decision (EU) 2023/2683 for calculating, verifying and reporting recycled plastic content in single-use beverage bottles. The latter decision is not a general food-contact authorisation. Its legal function concerns the evidence used to calculate recycled-content performance against the Single-Use Plastics Directive. [1–3]

This distinction is easily lost in procurement language. A sustainability team may request a specified recycled-content percentage, while a quality team requires evidence that the resulting bottle is suitable for prolonged contact with an acidic drink. Both questions are legitimate, but they involve different proof. Accounting can establish an attributed recycled-content quantity under an applicable allocation method; it cannot independently identify every molecule in the final bottle or establish the toxicological acceptability of migrants. Conversely, a satisfactory migration dossier does not demonstrate that a recycling-content target was met. Treating either file as a substitute for the other creates a preventable compliance gap.

2 | What changed in recycled-content accounting

Directive (EU) 2019/904 sets recycled-content targets for specified single-use beverage bottles: at least 25% recycled plastic for PET bottles from 2025 and at least 30% for plastic beverage bottles from 2030, calculated as required by the Directive and implementing methodology. These are Member-State-level target structures and should not be casually converted into an identical minimum for each individual bottle without analysing the relevant national implementation and applicable product rules. Decision 2026/1425 updates calculation and reporting architecture, including mass-balance accounting intended to accommodate additional recycling methods. [1,2]

Mass balance is an allocation convention linking qualifying inputs and outputs within defined system boundaries. It is not the same as physically segregating recycled polymer molecules into every finished article. The exact allocation constraints, eligibility conditions, chain-of-custody evidence and reporting period must be read from the operative Decision and its annexes; a supplier's broad statement that a facility is "mass-balance certified" is not a substitute for a legal mapping to the applicable methodology. Any claim about a specific bottle's physical recycled content must be distinguished from a certified allocated share.

3 | Chemical recycling does not denote one technology

The expression "chemical recycling" groups heterogeneous processes: depolymerisation, solvolysis, pyrolysis, gasification and other conversion routes. Their outputs, purification requirements, yield accounting and contaminant profiles differ substantially. PET depolymerisation to monomers followed by repolymerisation raises different technical questions from converting mixed plastic waste into hydrocarbon intermediates that enter a larger petrochemical system. The distinction matters both to accounting boundaries and to food-contact authorisation. [1,4]

A process producing purified monomers should not be presumed to qualify under exactly the same regulatory route as a mechanical PET recycling process. Nor does the fact that a recycled feedstock is chemically transformed prove that every relevant contaminant has been eliminated. Feedstock

variability, reaction by-products, catalyst residues, additive-derived impurities and downstream purification all require process-specific examination. The correct scientific question is not whether a process is labelled “advanced”, but what chemical material it yields, what is carried through, and what analytical evidence supports the intended contact use.

4 | Food-contact law remains an independent gate

Regulation (EC) No 1935/2004 provides the overarching EU safety principle: materials and articles must not transfer constituents to food in quantities capable of endangering health, bringing about unacceptable changes in composition, or deteriorating organoleptic characteristics under normal or foreseeable conditions of use. Regulation (EU) No 10/2011 adds specific requirements for plastic food-contact materials, including authorised substances, restrictions and migration testing. Regulation (EU) 2022/1616 addresses recycled plastic food-contact materials and recycling technologies, with specific provisions on feedstock, decontamination, quality assurance and declarations of compliance. [4–6]

The legal routes are not interchangeable. The scope of Regulation 2022/1616 contains exclusions, including certain production of authorised substances from waste for subsequent use under Regulation 10/2011. It would therefore be inaccurate to claim that every chemically recycled polymer automatically follows the same process-authorisation pathway as post-consumer mechanically recycled PET. The correct classification depends on the actual manufacturing route and output. Regardless of route, applicable food-contact safety obligations must be satisfied. A mass-balance certificate is not a migration report or declaration of compliance.

5 | The contamination problem begins before recycling

Post-consumer collection systems can receive food residues, detergents, fragrances, non-food containers, labels, inks and polymers with different use histories. Even nominally food-grade waste may contain incidental contaminants. Regulation 2022/1616 explicitly recognises the unpredictability of incidental contamination and establishes collection and quality-system controls for recycling processes within its scope. [4]

For manufacturers, this is a sampling and provenance problem rather than simply a percentage problem. A nominal 50% recycled share sourced from a controlled, characterised stream may be easier to qualify than a smaller share derived from poorly understood feedstock. The inference is conditional: controlled provenance does not remove the need for process validation. Effective supplier qualification should identify collection origin, sorting performance, contamination assumptions, changes in input mix and the process stages at which critical contaminants are expected to be removed.

6 | Migration is not a single universal number

Overall migration, specific migration and non-intentionally added substances (NIAS) address different analytical questions. Overall migration estimates the aggregate mass transferred under prescribed conditions; specific migration assesses selected chemicals against relevant restrictions; NIAS work investigates impurities, degradation products and reaction products that may not appear on an intentional ingredient list. A compliant overall-migration result cannot prove the absence of a particular high-potency migrant. Likewise, targeted tests cannot exclude all unanticipated substances. [5,6]

Testing must reflect foreseeable food composition, contact duration, temperature, surface-area-to-volume ratio and manufacturing conditions. Acidic beverages, carbonated drinks, hot-fill products and long-shelf-life juices can create distinct exposure scenarios. Migration studies must use legally appropriate simulants and conditions; accelerated testing must be justified rather than selected for convenience. Analytical uncertainty and limits of detection matter especially where the chemical identity of an unknown migrant is incomplete.

7 | The functional beverage makes the boundary visible

A beverage developer may optimise acidity, protein dispersion, colour, oxygen stability and shelf life while simultaneously changing packaging specifications. Acidic matrices and flavour systems can influence sorption, scalping and migration behaviour; oxygen permeability and closure design can affect oxidation and sensory stability. A recycled-content change should therefore trigger a finished-packaging compatibility review, not merely an update to sustainability claims. These are established materials-science concerns, although their magnitude is product-specific.

Consider a hypothetical functional beverage at pH 3.8 with added protein and natural flavour. Its bottle may meet a recycled-content accounting target and still require validation of migration, oxygen ingress, flavour retention, light exposure and shelf-life performance. The converse is also true: a technically excellent bottle cannot be advertised as containing a particular recycled percentage without evidence under the applicable accounting rules. Neither hypothetical example demonstrates a failure of any commercial recycled PET grade.

8 | The overlooked difference between recycled attribution and physical composition

Mass-balance allocation is useful where qualifying recycled feedstock enters an integrated manufacturing network and output cannot be physically segregated at molecular level. It can support verifiable attribution under prescribed rules, but does not ordinarily mean that a test of a single final bottle will reveal the allocated recycled fraction. Spectroscopy and polymer analytics can characterise composition and contamination; they generally cannot reconstruct an administrative allocation ledger from molecular structure alone.

The potential communication risk is a claim that implies a physically measured recycled fraction when the supporting evidence concerns allocated inputs. Under EU consumer-protection and environmental-claims principles, the exact wording and context matter. A company should not describe mass-balance attribution as a direct measurement of recycled molecules. Legal review must address the claim as displayed to consumers, not only the technical certificate held by procurement. This distinction is especially important for retailer private-label programmes operating across borders.

9 | EU and Spain: overlapping compliance responsibilities

Spain applies directly applicable EU food-contact regulations alongside its national enforcement architecture, with competent regional authorities and national coordination functions, including AESAN in food-safety matters. Packaging waste and producer-responsibility duties may also engage Spanish national legislation. The regulatory file should therefore identify which requirements

concern the packaging producer, the food packer, the importer, the brand owner and the extended-producer-responsibility operator. [3–6]

For a Spanish beverage business, a defensible release dossier should combine the food-contact declaration of compliance, supporting migration and NIAS assessment where applicable, supplier traceability, intended-use restrictions, packaging bill of materials, recycled-content calculation evidence and destination-market claims review. This is a recommended evidence architecture rather than a newly enacted mandatory document with that precise title. A single certificate stating "EU compliant" is not adequate due diligence unless its scope and underlying legal basis are clear.

10 | Great Britain, Northern Ireland and the United States

Great Britain's packaging and food-contact requirements must be checked under its applicable domestic legislation and subsequent amendments; Northern Ireland requires a separate analysis of relevant EU-linked obligations under the Windsor Framework. Neither territory should be presumed automatically subject to every new EU implementing act on identical terms. The UK Food Standards Agency and Food Standards Scotland have also highlighted a material safety boundary: in May 2025 they advised against using abandoned environmental plastics, including ocean-bound plastics, for food packaging because available evidence did not establish safety. That advice should not be generalised into a prohibition on all recycled plastics from controlled collection systems. [7]

In the United States, FDA food-contact regulation evaluates substances and intended uses through applicable legal mechanisms, including food-contact notifications and other authorisations where appropriate. US recycled-plastic guidance emphasises source control, contamination and the suitability of the recycling process; it is not equivalent to an EU mass-balance allocation certificate. A multinational company therefore needs two jurisdiction-specific matrices: one for recycled-content and environmental claims, another for food-contact safety and material identity. Neither can be copied wholesale from the other.

11 | The 2026 Packaging Regulation is not a universal immediate deadline

Regulation (EU) 2025/40 entered into force in February 2025 and generally applies from 12 August 2026, but individual duties have their own application dates, transitional arrangements and delegated or implementing measures. The European Commission issued guidance in June 2026 to support interpretation. A compliance calendar should identify each provision and its specific trigger, rather than assert that all packaging redesign requirements became enforceable on the same August date. [3,8]

The distinction is operationally important. Packaging qualification, artwork changes, material procurement and producer-responsibility reporting have different lead times. Prematurely replacing an established food-contact structure to meet an incorrectly assumed deadline can create avoidable validation costs. Equally, treating every provision as indefinitely deferred may leave a manufacturer exposed. The defensible response is a dated requirement register, periodically checked against the consolidated legal texts and competent-authority guidance.

12 | Evidence integrity and digital traceability

Digital traceability can connect resin grade, recycled-input source, allocation period, conversion batch, declaration of compliance, migration test, beverage filling lot and destination market. Such

systems are already familiar in quality management and supply-chain certification. The scientific opportunity lies in making contradictory claims visible across documents: for example, a certificate supporting attributed recycled content while marketing artwork implies physically segregated content, or a migration dossier validated for ambient water while the intended beverage undergoes hot filling.

Automated cross-checking should remain subordinate to authoritative source documents and human review. A language model can flag missing declarations or inconsistent dates, but cannot infer an authorisation from the absence of a warning. The highest-value digital design is not a decorative dashboard; it is an auditable chain of claims, evidence, legal scope and revision history. False-positive flags and false assurances should be measured in any pilot.

13 | Research & Innovation Opportunity

Unresolved problem. Recycled-content accounting, food-contact migration evidence and finished-beverage compatibility are frequently managed by different departments. Their datasets are related but not identical. Published regulations and industry certification methods address important parts of this problem; it would be unjustified to claim that mass balance, traceability or migration science are newly invented. The under-tested proposition is whether integrated, claim-specific qualification improves decision quality and reduces late packaging failures.

Hypothesis/not established fact. A Dual-Evidence Packaging Passport could link (i) the legally recognised recycled-content accounting basis, (ii) physical polymer and process identity, (iii) food-contact authorisation route, (iv) targeted and non-targeted analytical evidence, and (v) matrix-specific performance and shelf-life data. It could make it easier to identify where an apparently valid sustainability claim exceeds the scope of the food-safety evidence, or vice versa. Its effectiveness and regulatory acceptability are unproven.

Validation programme. Select three packaging systems and three beverage matrices with different acidity and processing profiles. Record resin provenance, allocation documentation, converter batch identity, applicable legal declarations and independent migration testing. Introduce controlled documentary inconsistencies into anonymised training dossiers. Compare standard supplier qualification with a structured evidence-passport review by blinded quality and regulatory teams. Measure time to discrepancy detection, false acceptance, false rejection, testing costs, changes required after pilot production and reproducibility across sites. Conduct shelf-life and sensory tests under intended distribution conditions. Publish the decision rules and limitations before claiming improved performance.

Regulatory constraints and industrial relevance. No private passport replaces a declaration of compliance, official-control procedure, authorised recycling route or applicable environmental-claim rule. Confidential supplier data require access controls and contractual governance. If independently validated, the approach could assist beverage brands, private-label manufacturers, recyclers, converters and laboratories. Its value would lie in more reliable qualification and fewer unsupported claims—not in a presumed improvement in consumer health.

14 | What the evidence establishes, and what it does not

Established legal facts. The EU has distinct instruments for recycled-content calculation, food-contact safety and packaging sustainability. Decision 2026/1425 changes calculation and verification rules; Regulation 2022/1616 governs specified recycled-plastic food-contact routes;

Regulation 2025/40 establishes broader packaging requirements with differentiated implementation dates. [1–6,8]

Established science. Recycling feedstocks may contain incidental contaminants; decontamination and migration depend on process and intended use. Chemical recycling encompasses materially different technologies. Recycled-content attribution and toxicological safety are different variables.

Expert interpretation. The best procurement decision is supported by two connected but independent evidence chains. Emerging research question. Whether a digital dual-evidence passport reduces erroneous supplier approvals remains to be tested. No general claim is made that chemically recycled plastics are safer or less safe than mechanically recycled plastics; any comparison requires process-specific data.

15 | Conclusion: two claims, two proofs

The decisive lesson of the 2026 transition is not that recycling targets and food safety are in conflict. They are complementary policy objectives that require different kinds of evidence. The percentage assigned to a bottle may be a valid result of an accounting system; the chemical safety of that bottle must be established under the applicable food-contact framework and intended conditions. Industry should reject the false choice between circularity and safety. The more ambitious objective is to make both claims independently demonstrable, mutually consistent and traceable to the actual packaging supplied. For food and biotechnology companies, this is a practical agenda for better science, better procurement and more defensible market communication.

Related Knowledge Areas

Food Safety; Regulatory Affairs; Processing Technologies; Sustainability; AI & Food; Emerging Research.

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