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Review Article

The Shifting Landscape of Food Additive Regulation in the EU: Cancer Risk, Scientific Uncertainty, and Regulatory Divergence

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Abstract

The regulation of food additives in the European Union represents one of the most comprehensive and precautionary approaches to food safety governance globally. However, the relationship between food additives and cancer risk has emerged as a particularly contested domain, characterised by evolving scientific evidence, regulatory divergence across jurisdictions, and significant economic implications. This narrative review examines recent EU regulatory developments concerning food additives with potential carcinogenic or endocrine-disrupting properties, focusing on the period from 2018 to 2026. It analyses the regulatory framework established by Regulation (EC) No 1333/2008, the re-evaluation programme mandated by Regulation (EU) No 257/2010, and specific case studies including titanium dioxide (E171), nitrite additives (E249-250), neotame (E961), and sucralose (E955). The review identifies a fundamental tension between hazard-based and risk-based regulatory approaches, explores the role of the European Food Safety Authority (EFSA) in shaping regulatory outcomes, and examines how differing interpretations of scientific evidence have led to regulatory divergence between the EU and other major economies. The review concludes that while the EU's precautionary stance on food additives reflects legitimate public health concerns, significant challenges remain in achieving regulatory coherence, managing scientific uncertainty, and balancing public health protection against economic and technological considerations.

Introduction

The regulation of substances intentionally added to food for technological purposes constitutes one of the cornerstones of modern food safety governance. Food additives—defined under Regulation (EC) No 1333/2008 as substances not normally consumed as food themselves but intentionally added for technological purposes—play an indispensable role in modern food production, serving as preservatives, colourants, sweeteners, antioxidants, and texturising agents. However, the presence of these substances in the food supply has long raised public health concerns, particularly regarding their potential to contribute to cancer risk through genotoxic, carcinogenic, or endocrine-disrupting mechanisms (1).

The European Union has developed one of the most rigorous regulatory frameworks for food additives globally, grounded in the precautionary principle and the requirement that all authorised additives undergo comprehensive safety assessment by the European Food Safety Authority (EFSA) prior to market authorisation. This framework mandates that additives must not pose a safety concern at proposed use levels, must demonstrate a reasonable technological need, and must not mislead consumers.

Moreover, the EU has established a systematic re-evaluation programme for all additives authorised before January 2009, recognising that scientific knowledge evolves and that assessments conducted decades ago may require revision in light of new evidence.

The nexus between food additives and cancer risk has assumed particular prominence in recent years, driven by several factors. First, advances in toxicological science have enabled more sensitive detection of genotoxic and carcinogenic effects, including the identification of endocrine-disrupting chemicals (EDCs) that may contribute to hormone-related cancers through mechanisms not previously well understood. Second, epidemiological research has strengthened associations between dietary factors and cancer incidence, with the International Agency for Research on Cancer (IARC) classifying processed meat as a Group 1 carcinogen, partly due to the role of nitrite additives in forming carcinogenic N-nitrosamines. Third, high-profile regulatory decisions—particularly the EU's 2022 ban on titanium dioxide (E171) as a food additive—have drawn attention to the potential for regulatory divergence between the EU and other major economies, raising questions about the scientific basis for such divergent approaches (2).

This narrative review aims to provide a comprehensive analysis of recent EU regulatory developments concerning food additives and cancer risk. It examines the regulatory framework governing food additives, analyses specific case studies that illustrate contemporary regulatory challenges, and explores the scientific and policy debates that shape regulatory outcomes. The review is organised as follows: Section 2 outlines the EU's regulatory framework for food additives and the re-evaluation programme; Section 3 examines specific case studies of additives with cancer-relevant concerns; Section 4 analyses regulatory challenges and tensions; Section 5 considers the implications of regulatory divergence; and Section 6 presents conclusions and future directions (1,2).

The EU Regulatory Framework for Food Additives

Legislative Foundations

The authorisation and use of food additives in the EU are governed by Regulation (EC) No 1333/2008, which establishes a harmonised Union list of authorised additives and sets conditions for their use . Under this regulation, a food additive may only be included in the Union list if it satisfies four cumulative criteria:

1) it does not pose a safety concern at the proposed level of use, based on available scientific evidence;

2) there is a reasonable technological need that cannot be achieved by other economically and technologically feasible means;

3) its use does not mislead the consumer; and

4) its use presents advantages and benefits for the consumer.

Safety assessment is conducted by EFSA prior to authorisation, with the assessment encompassing multiple domains including absorption, distribution, metabolism, excretion, sub-chronic and chronic toxicity, carcinogenicity, genotoxicity, and reproductive and developmental toxicity (2). For authorised additives, Acceptable Daily Intakes (ADIs) are established based on the No Observed Adverse Effect Level (NOAEL) identified in animal studies, divided by an uncertainty factor—typically 100—to account for interspecies differences and inter-individual variability. The ADI represents the amount that can be ingested daily over a lifetime without appreciable health risk.

The Re-evaluation Programme

A distinctive feature of the EU's approach is the systematic re-evaluation of all food additives authorised prior to 2009, mandated by Regulation (EU) No 257/2010. This programme recognises that many additives were assessed using scientific methodologies that may no longer meet contemporary standards, and that new scientific evidence may warrant revision of earlier conclusions. The re-evaluation programme established priorities based on the date of authorisation and the availability of new scientific data, with food colourings prioritised for completion by 2015, sweeteners by 2020, and all other additives by 2018. However, these deadlines have been extended as the scope and complexity of the re-evaluation task have become apparent [1,3].

Since 2003, EFSA has been responsible for the scientific assessment of food additives, with the responsibility passing through successive expert panels: the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) until 2008, the Panel on Food Additives and Nutrient Sources Added to Food (ANS) until 2018, and subsequently the Panel on Food Additives and Flavourings (FAF) . This institutional continuity has facilitated the development of consistent scientific assessment methodologies, although the evolution of scientific understanding has necessitated methodological refinements over time.

Hazard-Based versus Risk-Based Regulation

A fundamental tension in the regulation of food additives with cancer-relevant properties concerns the appropriate basis for regulatory decision-making: should regulation be hazard-based (prohibiting substances based on their intrinsic harmful properties regardless of exposure) or risk-based (assessing and managing risks based on the likelihood and severity of harm, considering exposure levels and affected populations)?

The hazard-based approach proceeds from the premise that if a substance can cause harm-particularly if it is genotoxic or carcinogenic—it should be banned irrespective of exposure levels. Proponents of this approach argue that for substances with carcinogenic or endocrine-disrupting properties, thresholds cannot be reliably established, and that vulnerable populations such as foetuses and children may be affected at very low doses. This perspective is particularly influential in the regulation of substances classified as carcinogenic, mutagenic, or reprotoxic (CMR), where the precautionary principle is applied stringently [3].

The risk-based approach, by contrast, assesses risk as a function of both hazard and exposure, recognising that the mere presence of a harmful substance does not necessarily constitute a

risk if exposure is sufficiently low. This approach typically relies on the establishment of ADIs derived from NOAELs, and permits the continued use of substances provided that estimated dietary exposure does not exceed the ADI. Critics of the risk-based approach argue that it may inadequately protect public health for substances with non-monotonic dose-response curves or for substances that accumulate in the body over time.

This tension is not merely theoretical but has significant practical implications for regulatory outcomes. As discussed below, it has been particularly salient in the re-evaluation of titanium dioxide and in debates over the appropriate regulatory approach to endocrine-disrupting chemicals. The EU has generally leaned toward a hazard-based approach for substances with genotoxic or carcinogenic properties, although this has not been applied uniformly across all additives and has generated controversy regarding the scientific basis for regulatory decisions [3].

Case Studies in Recent EU Regulatory Action

Titanium Dioxide (E171): A Watershed Decision

The most significant recent regulatory action concerning a food additive with cancer-relevant concerns is the EU's decision to ban titanium dioxide (TiO2, E171) as a food additive, effective from 7 August 2022. Titanium dioxide is a white pigment used extensively in food products including chewing gum, chocolate, bakery products, cheese, and confectionery, as well as in cosmetics and pharmaceuticals. The ban represents the culmination of a scientific debate that began with EFSA's 2016 re-evaluation of E171 and intensified following the publication of EFSA's 2021 opinion concluding that E171 could no longer be considered safe for use as a food additive [2,3].

The 2016 evaluation by EFSA's ANS Panel had concluded that there was no harm in using TiO2 as a food additive at present, but identified data gaps regarding reproductive toxicity and genotoxicity, and required additional studies from interested business operators. The 2019 FAF Panel re-evaluation, drawing on these additional studies, raised more serious concerns. EFSA's 2021 opinion concluded that the Panel could not rule out genotoxicity concerns, and therefore could not establish an ADI for E171. The Panel noted that E171 contains nanoparticles that may accumulate in the body, and that the available data on genotoxicity were insufficient to confirm safety.

The regulatory decision to ban E171 has been highly consequential. For the food industry, the ban has necessitated the search for substitutes that can replicate TiO2's opacity and whitening properties, with rice starch, rice flour, calcium carbonate, and corn starch being explored as alternatives. These substitutes typically require higher quantities to achieve the same effect, potentially affecting product formulation, costs, and consumer acceptance. The ban has also prompted the European Medicines Agency to consider whether a similar ban should apply to TiO2 used as a pharmaceutical excipient, which would have even more significant implications for the pharmaceutical industry.

The E171 ban has also exposed significant regulatory divergence between the EU and other major economies. The United States Food and Drug Administration (FDA), Health Canada, Food Standards Australia and New Zealand (FSANZ), the Ministry of Health, Labour and Welfare of Japan (MHLW), and the UK Food Standards Agency (FSA) have all concluded that there is insufficient evidence to justify a ban, and have permitted the continued use of TiO2 as a food additive. A weight-of-evidence review by Kirkland et al. (2022) evaluated 192 datasets on the genotoxicity of TiO2 particles and concluded that there was little evidence to suggest that food-grade TiO2 (E171) causes induction of genotoxicity. The UK Committee on Toxicity (COT) conducted an independent review and concluded that the data indicated TiO2 did not induce aberrant crypt foci (as a potential indicator of carcinogenicity), and that a NOAEL of 1,000 mg/kg body weight per day was robust. Based on this, the COT established an ADI of 10 mg/kg body weight per day and concluded that it was unlikely that there would be a risk to health from current UK dietary exposures (3).

This regulatory divergence raises profound questions about the interpretation of scientific evidence, the appropriate role of the precautionary principle, and the potential for regulatory decisions to disrupt markets and international trade. It also highlights the challenge of reaching scientifically robust conclusions when evidence is uncertain, and the influence of differing regulatory cultures and institutional frameworks on the interpretation of evidence.

Nitrite Additives (E249-250): Balancing Risks and Benefits

The regulation of nitrite additives (potassium nitrite, E249, and sodium nitrite, E250) illustrates another dimension of the challenge posed by food additives with cancer-relevant properties: the need to balance cancer risk against other health considerations. Nitrites are used as preservatives in processed meat products, where they serve the critical function of inhibiting the growth of Clostridium botulinum, the bacterium responsible for botulism. However, nitrites can react with secondary amines in meat to form N-nitrosamines, which are known carcinogens. The IARC monograph on red meat and processed meat classified processed meat as a Group 1 carcinogen, identifying N-nitrosamines as one of the biological mechanisms involved in colorectal cancer development [4].

The EU has addressed this risk through Regulation (EU) 2023/2108, which from October 2025 introduces lower maximum permitted levels for nitrite additives in processed meat products. This regulation represents an attempt to balance the risk of N-nitrosamine formation against the protective effect of nitrites against pathogenic bacteria. The European Commission's response to a parliamentary question on this issue emphasised that the regulation is "a balanced outcome that takes into account, on the one hand, the risk of nitrosamine formation resulting from the presence of nitrites in meat products and, on the other hand, the protective effects of nitrites against pathogenic bacteria".

The Commission also clarified that EFSA's 2017 evaluation of nitrite additives concluded that nitrites themselves are neither

genotoxic nor carcinogenic, and that the safety concern relates to N-nitrosamine formation rather than the nitrite additives themselves. This distinction is important for regulatory purposes: while the nitrite additives may be considered safe at permitted use levels, the N-nitrosamines formed as by-products of their use are carcinogens that require separate regulatory attention. The Commission noted that it is evaluating the possibility of setting limits and adopting measures to reduce the presence of N-nitrosamines in food under EU rules on contaminants.

The nitrite case study illustrates several important themes in the regulation of food additives and cancer risk. First, it demonstrates the complexity of risk-benefit analysis where a substance serves a critical technological function (in this case, food safety) while posing a potential cancer risk. Second, it illustrates the importance of distinguishing between the additive itself and its reaction products, which may have different toxicological properties. Third, it shows how regulatory responses can address cancer risk through indirect measures (such as reducing the conditions that promote N-nitrosamine formation) rather than by banning the additive itself [3,4].

The Commission has also supported research projects such as PHYTOME and NOCHEMFOOD to evaluate the substitution of nitrite-containing additives, and member states are conducting additional research, including the NitriFree project expected to conclude in 2026. These research initiatives reflect recognition that technological alternatives may ultimately provide a more satisfactory resolution to the risk-benefit challenge posed by nitrite additives.

Neotame (E961): Re-evaluation and Revision of the ADI

The re-evaluation of neotame (E961), published by EFSA in July 2025, demonstrates a different aspect of the regulatory process: the revision of an ADI in light of re-evaluation, and the conclusion that no safety concern exists at permitted use levels. Neotame is a high-intensity sweetener manufactured through the chemical synthesis of N-[N-(3,3-dimethylbutyl)-L-α-aspartyl]-L-phenylalanine 1-methyl ester. It was first evaluated by EFSA in 2007, when an ADI of 2 mg/kg body weight per day was established based on a 52-week dog study [5].

The 2025 re-evaluation, conducted by the FAF Panel, reviewed the available toxicological database, including studies gathered from the literature, and concluded that no new safety concerns had been identified. The Panel noted that neotame is rapidly absorbed and pre-systemically metabolised, with systemic intact neotame likely excreted in the urine along with its metabolites. The Panel considered that there was no concern for genotoxicity of neotame at the maximum permitted levels or reported use levels. A review of other endpoints from the available toxicological database did not indicate adverse effects at the highest doses tested.

Based on the 52-week chronic and 104-week carcinogenicity studies in rats, the Panel established a NOAEL of 1,000 mg/kg body weight per day and derived an ADI of 10 mg/kg body weight per day, applying a 100-fold uncertainty factor. This ADI is five times higher than the 2 mg/kg body weight per day ADI established in 2007, reflecting the availability of a more robust database and the identification of a higher NOAEL than the 200 mg/kg body weight per day used in the 2007 assessment. The Panel concluded that dietary exposure estimates for different population groups did not exceed the ADI for any exposure scenario, and that there was no safety concern at currently permitted and reported uses and use levels.

The neotame case study illustrates several important points about the regulation of food additives and cancer risk. First, it shows that re-evaluation can lead to the relaxation of regulatory restrictions if new evidence supports a higher ADI. This is important because it suggests that the regulatory framework is not uniformly ratcheting toward greater restrictiveness, but rather adjusts in response to the weight of scientific evidence. Second, it demonstrates the importance of distinguishing between the hazard and risk assessment: while a substance may be toxic at very high doses, the ADI represents a safe exposure level based on a substantial margin of safety. Third, it highlights the value of the re-evaluation programme in ensuring that regulatory decisions are based on the most up-to-date scientific evidence available (4,5).

The Panel also noted that the safety of impurities and degradation products is covered by the toxicity data available on neotame itself, as the major degradation product (NC-00751) is also the primary metabolite of neotame. This illustrates the importance of considering the entire exposure profile, including impurities and degradation products, in safety assessment.

Sucralose (E955): Extension of Use and Safety Considerations

The re-evaluation of sucralose (E955), published in February 2026, addresses both the safety of the additive at existing use levels and a proposed extension of use in fine bakery wares. The Panel confirmed that no safety concerns arose for genotoxicity of sucralose and its impurities and degradation products. Based on a weight-of-evidence approach, the Panel considered the decrease in body weight observed in rats as the relevant endpoint for deriving a reference point. The Panel performed a benchmark dose analysis on data from the combined chronic and carcinogenicity study, accounting for the poor palatability of sucralose through a modified benchmark dose response [5,6].

The resulting reference point was 55 mg/kg body weight per day (benchmark dose lower confidence limit), and the Panel concluded that there was no need to revise the current ADI of 15 mg/kg body weight per day. Exposure estimates considering currently authorised uses did not exceed the ADI. However, the Panel could not conclude on the safety of the proposed extension of use in fine bakery wares due to uncertainties regarding the potential formation of chlorinated compounds under the wide range of baking processes that may be applicable.

This case study illustrates the challenge of evaluating new uses of additives, particularly in applications where processing conditions (such as high temperature) may affect the stability of the additive and lead to the formation of potentially harmful degradation products. It also demonstrates that safety assessment

is not a one-time exercise but requires ongoing evaluation as new uses are proposed and new scientific evidence emerges.

Regulatory Challenges and Tensions

The Challenge of Endocrine-Disrupting Chemicals

A significant challenge in the regulation of food additives and cancer risk concerns the identification and regulation of endocrine-disrupting chemicals (EDCs), which are linked to hormone-related cancers and other non-communicable diseases. The health costs of EDC exposure in the EU are estimated at €163 billion annually. EDCs can be introduced into food through contamination (e.g., from pesticide residues or food packaging materials) or through the intentional addition of artificial additives, dyes, and sweeteners. Major EDCs of concern in the food supply include bisphenol A (BPA), phthalates, tartrazine, erythrosine, and perfluoroalkyl substances (PFAS).

A key challenge in regulating EDCs is that they do not necessarily exhibit classic dose-response relationships, and effects may be observed at very low doses. Moreover, the effects of EDC exposure may be passed down to future generations through epigenetic changes, altering gene expression without modifying the DNA sequence. This challenges the traditional toxicological paradigm that assumes thresholds below which no adverse effects occur, and calls into question the ADI-based approach to safety assessment (6).

Despite progress in regulating EDCs in pesticides and biocides, significant gaps remain in the regulation of EDCs in food additives and food contact materials. A 2019 report requested by the European Parliament found that food additives and food contact materials regulations lag behind in defining EDCs, providing guidance, establishing tests, and managing risks. The European Parliament subsequently adopted a resolution demanding a comprehensive and effective approach to regulating EDCs, including treating them with the same level of concern as CMR substances, adopting a clear definition of EDCs across all EU legislation, and considering the combined effects of exposure to multiple EDCs.

The EU has taken several steps to address these challenges, including refining criteria for identifying EDCs, supporting research through Horizon Europe, and implementing the One Substance-One Assessment (OSOA) approach. However, the absence of a comprehensive regulatory system that translates scientific evidence on EDC exposure into consistent rules across the entire food supply chain remains a significant gap.

Scientific Uncertainty and the Role of Precaution

A recurring theme in the regulation of food additives and cancer risk is the challenge of making regulatory decisions in conditions of scientific uncertainty. The EU's precautionary principle, embedded in the General Food Law, provides a basis for regulatory action even when scientific evidence is not conclusive. However, the application of the precautionary principle is contentious, as illustrated by the TiO2 case, where the EU's decision to ban the additive was based on concerns about genotoxicity that other regulators considered insufficient to justify regulatory action (7).

The challenge of scientific uncertainty is compounded by the difficulty of distinguishing between hazard and risk in public communication. While the ADI-based approach to risk assessment provides a clear framework for distinguishing between safe and unsafe exposure levels, the identification of a hazard (i.e., the potential to cause harm) is often interpreted by the public as indicating that the substance is dangerous at any level of exposure. This has led some commentators to argue that the EU's hazard-based approach to EDCs and other substances of concern may inadvertently undermine consumer confidence in the safety of the food supply.

The role of the Science-Policy Interface (SPI) is critical in managing this challenge. EFSA's scientific opinions provide the evidence base for regulatory decisions, but these opinions are themselves subject to scientific uncertainty and may be interpreted differently by different regulators. The SPI must navigate between maintaining scientific integrity and relevance to policy, while avoiding the politicisation of science. The differing regulatory outcomes in the EU and other jurisdictions regarding TiO2 illustrate the consequences of divergent interpretations of scientific evidence.

Regulatory Coherence and Consistency

A further challenge concerns the coherence and consistency of the EU's regulatory framework for food additives and cancer risk. The OSOA approach, designed to streamline chemical safety assessments across EU agencies, aims to address this challenge by ensuring greater coherence, efficiency, and transparency in chemical assessments. However, the implementation of OSOA has not yet fully resolved the inconsistencies that arise when substances are regulated under different legal frameworks (e.g., food, cosmetics, medical devices) [8].

The development of sector-specific EDC regulation across the food supply chain is another challenge. While pesticides and biocides have legal frameworks for EDCs, food additives and food contact materials lack clear definitions, mandatory testing, and clear approaches to regulation, weakening enforcement. The European Parliament has called for incorporating specific provisions on EDCs in relevant product regulations, but progress has been slow.

Regulatory Divergence and Global Implications

The TiO2 Precedent

The EU's ban on TiO2 as a food additive has created a situation of significant regulatory divergence between the EU and other major economies. The US FDA, Health Canada, FSANZ, MHLW of Japan, and the UK FSA have all concluded that there is insufficient evidence to justify a ban and have permitted the continued use of TiO2. This divergence has implications beyond the food sector, as the EU's regulatory decisions are often influential in other jurisdictions. Countries with limited regulatory capacity may follow the EU's lead, potentially leading to a de facto global standard. Conversely, the refusal of other major economies to follow the EU's lead may undermine the EU's regulatory leadership and create trade frictions [7,8].

The divergence raises fundamental questions about the

nature of regulatory science and the appropriate role of the precautionary principle. Proponents of the EU's decision argue that the precautionary approach is justified when there are unresolved safety concerns, particularly for genotoxicity. Critics argue that the EU's decision was based on an overly conservative interpretation of the evidence and that the burden of proof has been inverted, requiring industry to prove safety rather than regulators to demonstrate risk. This reflects a broader debate about the appropriate balance between protection and innovation in food regulation.

Implications for the Pharmaceutical Industry

The EU's TiO2 ban has also had implications for the pharmaceutical industry, where TiO2 is widely used as an excipient. The European Medicines Agency is currently evaluating the safety of TiO2 in pharmaceuticals, and a ban on pharmaceutical use is considered likely by 2025. Such a ban would have significant implications for the pharmaceutical industry, including the need for product redevelopment, revalidation, and regulatory submissions. The EMA has begun issuing technical and procedural recommendations to permit the substitution or removal of TiO2 from medications [8].

The pharmaceutical case illustrates the spillover effects of food additive regulation on other sectors. A substance banned in food may still be permitted in pharmaceuticals if the risk-benefit profile differs (e.g., if the benefits of the pharmaceutical product outweigh the risks of the excipient). However, concerns about TiO2 safety apply regardless of the context of use, and the EMA's ongoing evaluation reflects the need to ensure consistency across regulatory domains.

The Role of the IARC Classification

The IARC classification of processed meat as a Group 1 carcinogen has significantly influenced the regulatory debate on nitrite additives. IARC's classification, based on epidemiological studies and mechanistic evidence, has raised public awareness of the potential cancer risk associated with processed meat consumption. However, the classification has also highlighted the distinction between hazard and risk: while processed meat is classified as a carcinogen based on the evidence that it can cause cancer, the magnitude of the risk depends on the level of consumption. This distinction is important for regulatory decision-making, as it suggests that risk can be managed through consumption advice and product reformulation rather than necessarily requiring a ban [7,8].

The Commission's response to a parliamentary question on this issue emphasises that the regulatory response should be proportionate to the risk, and that the reduction of nitrite levels in processed meat products represents a balanced approach that takes into account both cancer risk and the protective effects of nitrites against pathogenic bacteria.

Conclusions and Future Directions

This review has examined recent EU regulatory developments concerning food additives with potential cancer-relevant properties, focusing on the regulatory framework, specific case studies, and the challenges and tensions that characterise this domain. Several key themes emerge from this analysis. First, the EU's regulatory framework for food additives is among the most comprehensive and precautionary globally, incorporating systematic re-evaluation of authorised additives and rigorous safety assessment. The re-evaluation programme has resulted in varied outcomes, including bans (TiO2), revisions of ADIs (neotame), and confirmation of safety at existing use levels (sucralose), reflecting the diversity of scientific evidence and the evolving nature of toxicological knowledge [9]. Second, the relationship between scientific evidence and regulatory decision-making is complex and contested, as illustrated by the divergent regulatory outcomes regarding TiO2 in the EU and other jurisdictions. The interpretation of genotoxicity data, the appropriate application of the precautionary principle, and the weighing of scientific uncertainty are all subject to legitimate differences of expert opinion and regulatory judgement.

Third, the challenge of balancing risks and benefits is central to the regulation of food additives with cancer-relevant properties, as illustrated by the nitrite case, where cancer risk must be balanced against the protective effects against pathogenic bacteria. This challenge is likely to become more salient as the use of food additives continues to evolve and as new scientific evidence emerges.

Fourth, the regulation of EDCs represents a significant challenge requiring new scientific approaches and regulatory frameworks. The absence of comprehensive EDC regulation in food additives and food contact materials is a significant gap that will require regulatory attention in the coming years.

Looking forward, several directions for regulatory development may be anticipated. First, the continued implementation of the OSOA approach should improve the coherence and consistency of chemical safety assessments across regulatory domains. Second, the development of sector-specific EDC regulation in food additives and food contact materials should address the current gaps in the regulatory framework. Third, ongoing research on the health effects of food additives, supported by Horizon Europe and other initiatives, should provide improved evidence for regulatory decision-making. Fourth, the challenge of regulatory divergence between the EU and other jurisdictions will require continued attention, particularly as new regulatory decisions are made and as the implications of existing divergence become clearer [10].

The regulation of food additives and cancer risk will undoubtedly remain a contested and evolving domain, shaped by scientific advances, regulatory innovation, and societal expectations. The EU's precautionary approach, while sometimes criticised as overly conservative, reflects a legitimate concern to protect public health from potential long-term risks. At the same time, the pursuit of regulatory coherence, the management of scientific uncertainty, and the balancing of public health protection against economic and technological considerations will continue to require careful attention from regulators, scientists, and all stakeholders in the food system.

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References

1. El Gemayel M (2025) Food-Borne Endocrine-Disruption: An EU Risk Governance Perspective. European Journal of Risk Regulation.
2. European Parliament (2026) Answer to Question E-004753/2025.
3. EFSA Panel on Food Additives and Flavourings. (2025) Re-evaluation of neotame (E 961) as food additive. EFSA Journal 23(7): e9480.
4. European Parliament (2019) Answer to Question E-000187/2019.
5. Bundesinstitut für Risikobewertung. (n.d.). Health risk assessment of food additives.
6. EFSA Panel on Food Additives and Flavourings (2026) Re-evaluation of sucralose (E 955) as a food additive and evaluation of a new application on extension of use. EFSA Journal.
7. International Sweeteners Association (2025) Re-evaluation of neotame (E 961) as food additive.
8. ASSSA (2018) Food additives and their regulated use.
9. UK Committee on Toxicity (2025) Safety of Titanium dioxide (E171) as a Food Additive.
10. Wairkar S, Dand C, Bajaj A (2025) EFSA prohibits titanium dioxide in food - should pharmaceuticals be next? Toxicology 513: 154089.