

Mandatory Microplastic Concentration Disclosure through Dietary Reference Intakes (DRIs): A Regulatory Intervention

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Introduction

Microplastics are now detected in a variety of food products including sea salt, sugar, fish sauce, and rice, raising concerns about their cumulative effects on health (European Commission 2023). In response, environmental policymakers and food safety agencies, including the Food Safety and Standards Authority of India (FSSAI), have underscored the need for data-driven interventions that generate reliable information specific to national contexts. Mandatory disclosure through Dietary Reference Intakes (DRIs) on food labels represents one such targeted regulatory intervention aimed at mitigating human exposure to microplastics. This paper situates the problem within food safety regulation and behavioral policy design, examining current regulatory gaps, consumer label-reading evidence, and detection feasibility before proposing a phased disclosure intervention.

Background and Significance

While India's Plastic Waste Management Rules (2016) and subsequent amendments represent a legislative step toward managing plastic pollution, their efficacy in mitigating microplastic contamination in the food chain is critically limited. The rules primarily target macro-plastic waste, emphasizing collection, recycling, and minimizing litter. However, they lack specific provisions to address the generation and environmental release of secondary microplastics—the invisible particles formed from the degradation of larger plastic items. This regulatory framework operates in a compartmentalized manner, where the mandate of the pollution control boards (waste management) does not intersect with the food safety responsibilities of the Food Safety and Standards Authority of India (FSSAI). Consequently, there is no mechanism to translate upstream waste management into downstream food safety standards, leaving a vast regulatory vacuum regarding permissible levels of microplastics in consumables. Public awareness campaigns under these rules focus on littering and recycling, not on the invisible pathway from degraded plastics to dietary intake, thus failing to address a core component of human exposure (Government of India, 2016; FSSAI, 2023).

The scale of this exposure is not hypothetical. A 2024 study by the environmental research organisation Toxics Link tested salt and sugar brands across India, packaged, unpackaged, and artisanal varieties alike and found microplastic contamination, in the form of fibres, films, fragments, and pellets ranging from 0.1mm to 5mm, in every single sample tested, regardless of brand size or packaging type (Toxics Link, 2024). The health stakes of this exposure are also beginning to be documented: researchers have detected microplastic fragments in human placental tissue, raising concern about gestational exposure pathways (Anifowoshe et al., 2025), and emerging cardiovascular research has linked the presence of plastic particles in arterial plaque to a significantly elevated risk of heart attack, stroke, and death (Marfella et al., 2024).

Together, this evidence establishes that the problem this paper addresses is both measurably present in the Indian food supply and plausibly consequential for health, even as the precise scale of risk remains under active investigation.

Literature Review

The utility of mandatory food labels as a public health tool is well-established, yet their effectiveness in altering consumer understanding and behavior is moderated by significant factors. Studies indicate that while labels are widely available, their comprehension and use are inconsistent. Research by Mehanna et al. (2024) confirms that while over half of consumers read labels, attention is heavily skewed toward dates and product names, with less than a third regularly consulting nutritional facts. This suggests that label placement and salience are paramount. The technical nature of nutrient

information (e.g., RDA percentages, chemical names) can act as a barrier to comprehension, especially among populations with lower health literacy. However, labels are demonstrably effective for motivated, health-conscious subgroups, and they create a normative standard that incentivizes product reformulation by the industry. The key insight for policy is that a label's impact is not inherent but designed; information must be positioned where consumers already look and presented in a clear, actionable format to bridge the gap between availability and understanding (Mehanna et al., 2024; Bleich & Wolfson, 2015).

While Mehanna et al.'s (2024) findings are suggestive, India-specific evidence offers a stronger base for an India-focused proposal. A 2025 scoping review synthesising 32 India-based studies on food label literacy found that comprehension and engagement vary significantly by education, age, and income, with younger, more educated, urban consumers engaging most with labels (Pahlani et al., 2025). A separate 2025 survey of Gen Z Indian consumers found that while only 18.3% of respondents consistently read food labels at all, 90% expressed interest in using QR codes or AI-based apps to access product information digitally—suggesting that on-pack text space is not the only viable disclosure channel available to policymakers.

Concern over microplastics shifted from a primarily environmental framing toward a human-health framing only recently. The term “microplastics” was formally defined in 2004, but it was not until 2022 that microplastics were first detected in human blood, prompting a rapid expansion of toxicological research (Li et al., 2025). The World Health Organization's 2022 review of dietary and inhalation exposure marked the first major international attempt to assess health implications, but concluded that data on human exposure, dosimetry, biokinetics, and toxicological effects remained too sparse to support a definitive risk assessment (WHO, 2022)—a finding that still largely holds today and shapes how this paper frames its own proposal below.

For a mandatory labeling policy to be feasible, robust, standardized, and scalable methods for detecting and quantifying microplastic (MP) concentration in food products are essential. Recent advancements, particularly those leveraging artificial intelligence (AI), offer promising pathways for industrial application. Conventional detection methods like optical microscopy, thermo-analytical techniques, and hyperspectral imaging are reliable but too slow for high-throughput industrial testing (Rawat et al., 2025). Pairing spectroscopic techniques such as Raman and FTIR with machine learning classifiers has begun to close this gap: one CNN-based system has achieved roughly 85% classification accuracy on particles under 10 micrometers using sub-second exposure times, and a YOLOv11n deep-learning model has demonstrated real-time inference speeds of approximately three milliseconds per image with low computational overhead, suggesting that real-time, in-line detection during food processing is becoming computationally realistic rather than purely theoretical.

Despite growing scientific evidence of MP prevalence, a critical regulatory gap persists: the absence of standardized, legally enforceable limits for MP concentrations in food and beverages. Public awareness and concern are increasing, but without binding standards, industry lacks a clear mandate for mitigation. Existing regulations, such as India's Plastic Waste Management Rules, 2016, focus primarily on macro-waste management—mandating minimization, segregated storage, and proper disposal. While foundational, these rules are inadequate for addressing secondary microplastics that form from the degradation of this waste and subsequently contaminate the food chain. The current framework addresses the symptom (waste) but not the pervasive outcome (food contamination). This lack of a direct “cap” or Maximum Permissible Limit (MPL) for MPs in food products means manufacturers have no legal benchmark to meet, and consumers have no safety threshold to reference. Beyond this regulatory vacuum lies a deeper scientific constraint: no international body has yet established a validated, health-based reference value for microplastic particles themselves. The European Food Safety Authority's tolerable daily intake work has targeted specific leachable chemicals such as bisphenol A, not particle counts (FAO, 2018), and reviews of EU-FORA risk

assessment work confirm that data gaps in both exposure and toxicity currently prevent the kind of risk assessment a true Dietary Reference Intake would require (BfR/EU-FORA Fellowship Programme, 2020). Any disclosure policy proposed in this paper must therefore be designed around this constraint rather than assume it away.

Research Question

Given the absence of validated health-based reference values for microplastics, this paper asks: how can regulatory disclosure be designed to meaningfully inform Indian consumers about microplastic exposure even before a scientific consensus on safe intake thresholds exists? It further asks whether existing consumer label-reading behavior can be used to design a phased intervention, one that begins with standardized, transparent disclosure now, and builds toward enforceable limits as the underlying science matures.

Argument

Regulatory bodies like the FSSAI must commission large-scale surveillance to establish national baseline data on MP concentrations in key food categories. Drawing from AI-enhanced industrial detection data, science-based "Daily Intake Reference" values for MPs could be formulated, analogous to other contaminants. Crucially, this information must be disclosed mandatorily on labels. Consumer behavior research, such as the study by Mehanna et al., clearly indicates that the most frequently read sections of a label are the production/expiry dates (76.8%). Therefore, to ensure high visibility, the MP concentration (e.g., "Estimated Microplastic Content: X µg/serving") should be placed directly adjacent to or beneath this high-traffic information. This placement strategically inserts MP exposure data into the existing consumer reading routine, thereby enhancing the likelihood of notice and comprehension. Importantly, this is not a request to build surveillance infrastructure from scratch. FSSAI has already launched a dedicated project, in collaboration with CSIR's Indian Institute of Toxicology Research, ICAR's Central Institute of Fisheries Technology, and BITS Pilani, to standardise detection protocols and generate baseline national exposure data (FSSAI, 2024). The proposal in this paper builds directly on that existing pipeline rather than asking for a parallel one.

Given that on-pack space is limited and that surveyed consumers show strong appetite for digital product information—90% expressed interest in QR-code or AI-app-based access in one recent India-based survey—this paper proposes that microplastic disclosure be implemented as a QR-linked digital label rather than solely as printed text. This allows for more detailed information (estimated particle count, polymer type, source category) than label space permits, while the printed label carries only a brief flag and code, preserving the high-visibility placement near production/expiry dates that both Mehanna et al. (2024) and Pahlani et al. (2025) identify as the most-read label zone.

Disclosure alone is insufficient without a safety benchmark. Concurrently, regulators must establish phased MPLs for different food categories. These limits would act as a "cap," creating a legal and economic incentive for producers to invest in filtration, improved packaging, and cleaner supply chains to reduce MP loads. Products exceeding the MPL would be non-compliant, similar to violations of microbial or heavy metal standards. This regulatory "stick" complements the "carrot" of informed consumer choice, driving systemic change toward source reduction.

A reasonable objection to this proposal is that mandating disclosure of a contaminant for which no validated safety threshold exists risks misleading consumers or causing disproportionate alarm, since international scientific bodies have explicitly stated that current data are too sparse to support a health-based reference value (WHO, 2022). This paper addresses that concern through a two-tier model. Tier 1 requires only standardised, comparative disclosure of estimated particle count per serving—informational rather than evaluative, similar to how trans-fat content was disclosed on labels years before regulatory bodies set definitive health-based limits for it. Tier 2, enforceable Maximum Permissible Limits, would be introduced only once FSSAI's ongoing surveillance project and the

broader international toxicological literature mature sufficiently to support a defensible threshold. This phasing allows transparency to begin immediately without making a premature scientific claim the policy cannot yet support.

Conclusion

The widespread presence of microplastics in food necessitates a regulatory response that is both actionable and informed by consumer behavior. While industrial-scale AI detection methods enable accurate monitoring (Mir et al., 2023), current regulations lack binding limits for food contamination. A practical two-part policy is proposed. First, science-based Maximum Permissible Limits (MPLs) must be established to compel industry-wide reduction. Second, mandating the disclosure of microplastic concentration on labels is critical. Crucially, to ensure visibility, this data must be placed adjacent to production/expiry dates, the label element read by 76.8% of consumers (Mehanna et al., 2024)—rather than in less-viewed nutritional panels. This strategic placement, backed by enforceable MPLs, directly leverages existing consumer habits to foster awareness and choice, while creating a mandatory incentive for producers to minimize plastic pollution at its source.

This proposal also has limitations worth acknowledging. Relying solely on upstream waste management reforms, as India's current Plastic Waste Management Rules attempt, addresses plastic pollution at its source but does nothing to inform consumers about contamination already present in the food they currently purchase, hence the need for the disclosure-first approach argued for above. The proposal itself is also not without limitations: Tier 1 disclosure depends on standardised detection protocols that are still being validated, enforcement capacity within FSSAI remains constrained, and there is a risk that "estimated particle count" figures, without an accompanying safety interpretation, could be misread by consumers as more or less alarming than current science actually supports.

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