

Review Article

The label you can't read: food preservatives, consumer awareness and regulatory accountability in India – preservatives and labelling awareness in India

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ABSTRACT

India's expanding processed-food market relies heavily on chemical preservatives, colourants, and other additives, yet many Indian consumers cannot reliably interpret this information on food labels, and enforcement of labeling and safety standards remains inconsistent for low-cost products. This narrative review synthesises evidence on preservatives commonly used in Indian food, associated health evidence, the regulatory and labeling framework administered by the Food Safety and Standards Authority of India (FSSAI), documented adulteration patterns, and consumer label literacy, drawing on peer-reviewed literature, FSSAI regulatory documents, Codex Alimentarius standards, and recent government and judicial records (2018–2026). Preservatives such as sodium benzoate, sulphites, nitrates/nitrites, and synthetic antioxidants and colourants are broadly recognised as safe within prescribed limits, yet excessive or combined intake has been linked to oxidative stress, endocrine and reproductive effects, and neurobehavioural changes in children. Indian surveillance data show persistently high rates of substandard and adulterated food, disproportionately affecting economically vulnerable consumers. Studies of Indian consumers show that while awareness that food labels exist is high, functional comprehension of ingredient lists, additive codes, and preservative disclosures remains low, and is strongly patterned by education, income, and urban rural residence. India's labelling regulations are comprehensive on paper, but enforcement capacity, front of pack warning systems, and public label literacy lag behind comparable jurisdictions. Strengthening preservative safety oversight, mandating simplified vernacular front-of-pack warnings, and investing in consumer health literacy programmes are identified as priority interventions to close this gap in India.

Keywords: Food preservatives, Food labelling, FSSAI, Consumer awareness, Food adulteration, India

INTRODUCTION

Food preservatives substances added to inhibit microbial growth, oxidation, and spoilage have been central to extending the shelf life and geographic reach of the food supply since the early twentieth century. In India, the scale of processed and packaged food consumption has grown sharply over the past decade, driven by urbanisation, dual-income households, and the expansion of low-cost packaged snacks, beverages, dairy analogues, and street-vended foods.

Alongside this growth, two related public-health concerns have intensified. First, cost pressure in a highly price-sensitive market creates incentives for manufacturers particularly smaller and unregistered food businesses to use cheaper, and sometimes non-permitted or excessive, preservatives, colourants, and adulterants to reduce spoilage losses and production cost, rather than through proper cold chain infrastructure or hygienic processing.^{1,2,3} Second, even where preservative use is within permitted limits, the consumer's ability to identify what has been added, at what level, and with what health

implication is limited by low functional label literacy across large sections of the population.^{4,5}

India's labeling and food-additive regime is, on paper, aligned with international norms: the Food Safety and Standards Authority of India (FSSAI) mandates declaration of additives by class name and International Numbering System (INS) code under the Food Safety and Standards (Labelling and Display) Regulations, 2020, in a manner broadly consistent with the Codex Alimentarius General Standard for Food Additives (GSFA).⁶⁻¹⁰ However, a persistent gap exists between the technical completeness of these disclosures and their practical usefulness to an ordinary consumer at the point of purchase – a gap that has recently drawn direct judicial scrutiny, with the Supreme Court of India criticising FSSAI in 2026 for delaying the introduction of simplified front-of-pack warning labels for foods high in sugar, salt, and saturated fat.¹¹⁻¹³

This review brings together evidence on preservative use and safety, India's regulatory and labeling architecture, documented adulteration patterns associated with low-quality and cheap food products, and empirical studies of Indian consumer label literacy, with the aim of identifying concrete, actionable gaps for policy, industry, and public-health practice.

METHODOLOGY

This is a narrative review structured around five thematic domains; (i) classification and common use of food preservatives in India; (ii) health evidence associated with preservative and additive exposure; (iii) India's regulatory and labeling framework; (iv) documented adulteration and quality patterns in low-cost food products; and (v) consumer awareness and label literacy. Literature was identified through PubMed/PMC, ScienceDirect, and Google Scholar for peer-reviewed studies, supplemented by primary regulatory sources (FSSAI notifications and regulations, Codex Alimentarius/GSFA database, FAO/WHO JECFA outputs) and recent (2024–2026) government data, parliamentary replies, and judicial records to capture the current state of the front of pack labeling debate. Sources published between 2011 and 2026 were prioritised, with earlier foundational toxicology and regulatory sources included where relevant. As a narrative rather than systematic review, this work does not apply formal risk-of-bias scoring or meta-analysis; it aims instead at thematic synthesis relevant to the Indian public-health and regulatory context.

FOOD PRESERVATIVES AND RELATED ADDITIVES: CLASSIFICATION AND USE IN INDIA

Chemical (Class I and Class II) preservatives

Benzoates (sodium benzoate, INS 211) and sorbates (potassium sorbate, INS 202) are among the most widely

used antimicrobial preservatives in Indian beverages, squashes, sauces, pickles, and bakery products, valued for their low cost and broad-spectrum activity against yeast, mould, and bacteria.^{14,15} Sulphites (sodium/potassium metabisulphite) are used to prevent browning and microbial spoilage in dried fruit, wine, and some fruit-based products. Nitrates and nitrites (sodium nitrite, INS 250; sodium nitrate, INS 251) are used principally in processed and cured meat products for antimicrobial control (notably against *Clostridium botulinum*) and colour stabilisation.¹⁴ Synthetic antioxidants butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and tertiary butylhydroquinone (TBHQ) are added to fats, oils, and snack foods to delay rancidity.¹⁴

Synthetic colourants associated with preservation and adulteration

Although classified separately from preservatives, synthetic azo dyes such as tartrazine (INS 102), sunset yellow (INS 110), and carmoisine are frequently discussed alongside preservatives in Indian food safety surveillance because they are commonly used, in permitted or non-permitted quantities, in the same low cost confectionery, beverage, and snack categories.^{16,17} Non permitted industrial dyes such as metanil yellow and Sudan dyes have repeatedly been detected as illegal adulterants in turmeric, chilli powder, and sweets sold in the unorganised sector, representing a distinct and more serious category of violation beyond simple over use of a permitted additive.¹

Natural and 'clean-label' alternatives

Growing consumer preference for minimally processed food has driven interest in natural preservation systems plant derived antimicrobials, bacteriocins, essential oils, and fermentation based bio-preservation that are increasingly evaluated and, where approved, listed under the Codex GSFA alongside conventional synthetic preservatives.^{9,18} While promising, these alternatives generally have narrower antimicrobial spectra, higher cost, and greater sensitivity to processing conditions than synthetic preservatives, which has limited their adoption in India's price-sensitive mass market.¹⁸

HEALTH IMPLICATIONS OF PRESERVATIVE OVERUSE AND MISUSE

Regulatory agencies worldwide, including FSSAI, permit the preservatives discussed above only within an Acceptable Daily Intake (ADI) established through toxicological review, typically by the Joint FAO/WHO Expert Committee on Food Additives (JECFA).⁹ The health evidence reviewed below therefore concerns risk associated with intake above permitted levels, cumulative exposure across multiple products, or susceptible sub-populations – not an argument that permitted, correctly labelled use is inherently unsafe.

Benzoates and sorbates

Sodium benzoate carries an ADI of 0–5 mg/kg body weight per day as established by international and national regulators, and is generally recognised as safe within this range.^{19,20} However, a growing experimental literature associates higher or chronic exposure with oxidative stress, genotoxic and mutagenic effects, endocrine disruption, and reduced fertility in animal models.^{1,14,19} An 8-week rodent study found that sodium benzoate and potassium sorbate, individually and in combination, produced measurable reductions in testicular weight, sperm count and viability, and plasma testosterone even at no-observed-adverse-effect-level (NOAEL) doses, raising concern about the effect of combined, everyday exposure to multiple additives rather than any single compound in isolation.²¹ Sodium benzoate can also react with ascorbic acid (vitamin C) in acidic beverages to form benzene, a recognised carcinogen; regulatory testing in some markets has identified benzene levels exceeding drinking-water safety thresholds in a minority of tested beverages combining both ingredients, prompting reformulation.²² Benzoate has additionally been linked, in a subset of sensitive individuals, to urticaria and hyperactivity, and to interference with neurotransmission via inhibition of D-amino acid oxidase.^{14,23}

Nitrates and nitrites

Nitrite's antimicrobial and colour fixing properties make it valuable in cured and processed meat, but nitrites can convert to N-nitroso compounds, including nitrosamines, in the presence of amino acids under certain cooking and digestive conditions; nitrosamine exposure has been associated with increased cancer risk in experimental and epidemiological studies, contributing to international dietary advisories recommending limits on processed meat consumption.^{14,22,24}

Sulphites

Sulphite preservatives, while effective against browning and spoilage, can trigger asthma-like bronchospasm and allergic reactions in sulphite-sensitive individuals, and emerging evidence suggests they may alter gut and oral microbiota composition.¹⁶

Synthetic antioxidants (BHA/BHT/TBHQ)

BHA and related synthetic antioxidants have been the subject of long-standing toxicological debate; several reviews of chemical preservatives flag BHA and TBHQ among the additives warranting continued monitoring for chronic health effects with long-term or high-level use, though they remain permitted within regulatory limits in most jurisdictions, including India.¹⁴

Synthetic colourants and neurobehavioural effects in children

The strongest and most policy relevant evidence on additive related harm concerns synthetic azo dyes and their interaction with certain preservatives in children. A landmark UK study (the Southampton/'Lancet' study) found that a mixture of common food dyes (including sunset yellow, tartrazine, and carmoisine) combined with sodium benzoate increased hyperactivity in both 3-year-old and 8 to 9 year old children in a general population sample, using a double-blind, placebo-controlled design.²⁵ Subsequent reviews and regulatory assessments, including by the California Office of Environmental Health Hazard Assessment, have concluded that the evidence supports an association between synthetic dye exposure and adverse behavioural outcomes inattentiveness, hyperactivity, and restlessness in sensitive children, with and without pre-existing behavioural diagnoses.²⁶ Tartrazine specifically has been associated with allergic and pseudo allergic reactions, asthma-like symptoms, and, in animal studies, genotoxic and teratogenic effects.^{10,17} Because tartrazine is markedly cheaper than natural colourants such as saffron, it is disproportionately used including at non-permitted levels in low-cost confectionery, beverages, and festive sweets targeted at children, a pattern repeatedly confirmed in food-safety surveillance in South Asian markets.^{10,16}

Cumulative and vulnerable-group considerations

A recurring theme across the reviewed toxicological literature is that individual ADIs are derived largely from single compound exposure studies, while real-world consumption particularly among children consuming multiple ultra-processed, brightly coloured, and preservative-laden products daily involves simultaneous, cumulative exposure to several additives.^{17,21} This 'cocktail effect' remains inadequately captured by additive by additive regulatory review and represents an important area for future risk-assessment methodology.

INDIA'S REGULATORY AND LABELLING FRAMEWORK***Institutional and legal basis***

FSSAI was established under the Food Safety and Standards Act, 2006, and consolidated multiple preexisting food laws into a single statutory authority responsible for science based standard setting, licensing, and enforcement, operating alongside state food safety departments who conduct most ground level inspection and sampling.^{3,27}

Additive and preservative standards

Permitted preservatives, their maximum use levels, and the foods in which they may be used are prescribed under the Food Safety and Standards (Food Products Standards

and Food Additives) Regulations, 2011, which is broadly harmonised with the Codex Alimentarius GSFA and its International Numbering System (INS).^{9,10,28} India's food additive standards therefore align closely, in structure, with the European Union's E-number system and the United States FDA's Generally Recognised as Safe (GRAS)/direct food additive framework, all of which trace to overlapping JECFA safety evaluations, even though the specific additives permitted and their maximum levels can differ by jurisdiction.^{9,10}

Labelling requirements

The Food Safety and Standards (Labelling and Display) Regulations, 2020 which replaced the 2011 Packaging and Labelling Regulations require that every pre-packaged food declare, among other elements, a complete ingredient list in descending order of proportion, the FSSAI logo and license number, net quantity, date marking, manufacturer/importer details, and any food additive by its functional class name together with its INS number or specific name (for example, 'Preservative (INS 211)' or 'Colour (INS 102)').^{6,7,8} Common labelling violations documented in compliance reviews include declaring additives by brand name rather than INS number, omitting mandatory nutrient declarations such as transfat, and making unsubstantiated 'no preservative' or 'natural' claims on products that in fact contain permitted synthetic preservatives or colours.⁸

The front-of-pack labelling debate (2022–2026)

A significant, currently unresolved regulatory gap concerns front-of-pack nutrition labelling (FOPNL). FSSAI first proposed a star-rating-based 'Indian Nutrition Rating' system in a September 2022 draft notification, but the proposal was not finalised.²⁹ In June 2024, FSSAI approved a narrower amendment requiring bold-font, larger-size disclosure of total sugar, salt, and saturated fat on the existing nutrition panel, which was notified as mandatory by December 2024.³⁰ This fell short of an interpretive front-of-pack warning system. Following a public-interest litigation, the Supreme Court of India directed FSSAI in February 2026 to reconsider a warning-label design explicitly flagging products 'High in Sugar', 'High in Salt', or 'High in Saturated Fat'.^{13,31} In its August 2026 compliance affidavit, FSSAI instead proposed displaying numeric recommended daily limits (for example, 25 g sugar, 10 g saturated fat, 5 g salt, based on the ICMR–National Institute of Nutrition 2024 Dietary Guidelines for Indians) alongside per-100g nutrient values, without an interpretive warning symbol a proposal the Court criticised as requiring consumers to perform their own calculations rather than receiving a clear, immediately interpretable signal, and one that public-health advocates noted diverged from FSSAI's own 2022 definition of high-fat-sugar-salt (HFSS) foods.^{11–13,27,31} As of mid-2026, the matter remains before the Supreme Court, with the Bench explicitly questioning

whether FSSAI's reluctance reflects industry influence.^{11,12}

This unresolved debate is directly relevant to the theme of this review: even a fully additive- and preservative-compliant label, declared correctly under the 2020 Regulations, does not by itself communicate risk in a form accessible to a consumer with limited nutritional or chemical literacy the core problem explored in Section 7.

FOOD ADULTERATION, LOW-QUALITY PRODUCTS, AND THE ECONOMICS OF CHEAP FOOD

A distinct but closely related threat to preservative labelling compliance is outright food adulteration the addition of non-permitted, unsafe, or undeclared substances, often driven by cost-cutting in the unorganised and semi-organised food sector. National surveillance data indicate that food-adulteration and safety complaints registered with FSSAI rose from 4,330 in 2022–23 to 7,705 in 2024–25.³² Sample-testing data show consistently high non-conformance rates: FSSAI reported that approximately 20% of food samples tested nationally in 2024–25 failed to meet safety standards, with substantial state-level variation Uttar Pradesh (52.8%), Rajasthan (28.4%), and Maharashtra (18.7%) among the highest.³ A separate assessment of the 2025–26 fiscal year reported a 17.16% failure rate across more than 165,000 samples tested nationally.³³ Regional data from South India (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana) show that roughly one in seven samples tested between 2021 and 2024 was non-conforming.²⁴

Commonly documented adulterants include detergent, urea, starch, and synthetic substitutes in milk; industrial dyes such as metanil yellow and Sudan dyes in turmeric and chilli powder; argemone and mineral oil in edible oil; and lead chromate in turmeric.^{1,3} Dairy products have shown particularly high failure rates in some urban surveillance exercises one study of paneer sampled in Noida and Greater Noida found 83% of samples failed quality tests, with 40% classified as unsafe due to harmful chemical contamination.² Spice contamination affected approximately 12% of nationally tested spice samples in recent surveillance.² These patterns disproportionately affect low cost, loose, and locally branded products rather than large branded manufacturers, reflecting weaker quality control, cold chain infrastructure, and regulatory reach in the unorganised sector that serves price sensitive consumers.^{1–3}

Enforcement capacity constraints compound this problem: commentators have repeatedly identified shortages of trained food safety officers and testing infrastructure as a structural limitation on FSSAI's and state authorities' ability to bring all food business operators under effective licensing and inspection, even as the volume of complaints and testing has grown.³

CONSUMER AWARENESS AND LABEL LITERACY IN INDIA

A substantial and growing Indian research literature has examined how consumers engage with food labels, generally converging on a distinction between label awareness (knowing that labels exist and contain information) and label literacy or comprehension (being able to interpret and act on that information) with the former consistently found to be far higher than the latter.^{4,5}

Awareness is high; functional use is low

A cross-sectional study across Ahmedabad, Surat, Vadodara, and Rajkot involving 2,192 respondents found that 95.8% were aware of nutrition labels and 88% reported reading them, yet actual influence on purchase decisions and understanding of specific nutrient information remained limited, and factors such as ambiguous terminology were repeatedly cited as barriers to meaningful use.³⁴ A separate survey found that only around 50% of participants reported reading package information before purchase, and 85% did not consider mislabelling a public-health risk, with health awareness rated as the least important motivational factor in label use.³⁵ In a cross-sectional study among 1,832 consumers in Delhi and Hyderabad, 92% reported referring to food labels, yet detailed compliance auditing of the same product categories found nutrition information present on only 59.5% of branded and 34% of local products, and health/nutrition claim substantiation present in only 10–29% of labels reviewed.³⁶

What consumers actually read

Across multiple Indian studies synthesised in a 2024–25 scoping review, consumers consistently prioritise expiry dates, price, brand name, and the vegetarian/non-vegetarian symbol, while engagement with ingredient lists, additive/preservative codes, and detailed nutrient content (sodium, sugar, fat) is markedly lower and often described by participants themselves as unnecessary or too time-consuming to check.⁴ A South Chennai study of 415 consumers found that while 85.8% were aware of food labels and 70.1% used them while shopping, only 51.8% demonstrated good label-reading practice and just 32.1% reported it as a common practice, with safety-related elements (expiry dates) consistently prioritised over nutritional detail.⁵ Barriers identified across studies include small font size, technical/chemical jargon (including INS/E-numbers for preservatives), limited time at point of purchase, poor understanding of what specific nutrients or additive codes mean, and habitual reliance on brand trust rather than label content.⁴

Socio-demographic determinants

Education level, income, age, gender, employment status, and urban versus rural residence are consistently

associated with food-label engagement and comprehension across Indian studies, though the strength of association varies. A national survey of 2,127 respondents on edible oil labelling found a statistically significant, though weak, association between higher educational attainment and label-reading practice, with younger respondents showing somewhat higher awareness than older groups.³⁷ The South Chennai study similarly found education and employment status to be strong predictors of adequate label knowledge, with positive associations between knowledge, attitude, and practice.⁵ Across the wider literature, women, younger adults, and more educated respondents were more likely to report reading labels, most commonly checking expiry dates rather than ingredient or additive information.⁴

The perception gap around preservatives specifically

A recurring and policy-relevant finding is that Indian consumers, even when they read labels, frequently do not perceive additive and preservative disclosures as safety relevant information, and a large majority (85% in one study) do not consider mislabelling a public-health risk at all.³⁵ This suggests the core problem in India is not merely regulatory non-disclosure since FSSAI's 2020 Regulations do mandate additive declaration but a combination of low functional chemical literacy, label design that does not foreground risk-relevant information, and the absence of an interpretive (as opposed to purely informational) labeling layer such as the front-of-pack warning system still pending before the Supreme Court.^{11,13,31}

INTERNATIONAL COMPARISON

India's additive labelling architecture functional class name plus INS number mirrors the European Union's E-number system and is built on the same underlying Codex Alimentarius GSFA and JECFA safety evaluations that inform United States FDA additive regulation, reflecting broad international harmonisation at the level of technical disclosure.^{9,10} Where jurisdictions diverge sharply is in interpretive front-of-pack communication. Chile's mandatory black octagonal warning labels for products high in sugar, sodium, saturated fat, or calories have been associated with measurable reductions in purchases of flagged high-sugar beverages and have driven manufacturer reformulation; Mexico adopted a comparable bold warning-label system with similar reported effects; and the United Kingdom uses a colour-coded 'traffic light' system (red/amber/green) for fat, sugar, and salt.³⁸ India, by contrast, had as of mid-2026 not yet implemented any interpretive front-of-pack system, relying instead on a numeric nutrition panel that requires the consumer to compare product values against separately stated daily limits, an approach explicitly contrasted with the Chile/Mexico/UK model in Indian Supreme Court proceedings.^{11,27,38} This positions India as an outlier among large food markets in translating technically complete additive and nutrient disclosure into

a format usable by consumers with variable literacy the central theme of this review.

GAPS AND CHALLENGES

Regulatory

Front of pack interpretive warning labelling remains unresolved as of 2026 despite a decade of policy discussion and active judicial intervention, leaving the numeric nutrition panel as the primary consumer-facing safety signal.^{11-13,27,31}

Enforcement

Persistent shortages of food safety officers and testing infrastructure limit the reach of inspection and sampling, particularly for unregistered and small food businesses that account for a disproportionate share of adulteration findings.³

Label design

Even fully compliant labels use technical INS/class-name terminology, small font sizes, and predominantly English/limited-language text that is not optimised for comprehension by consumers with lower literacy or limited English proficiency.^{4,5}

Consumer literacy

Awareness that labels exist substantially exceeds the ability to interpret specific preservative, additive, or nutrient information, and mislabelling is often not perceived as a health risk at all.^{4,35}

Cumulative exposure assessment

Regulatory ADIs are generally derived additive-by-additive, while real-world exposure particularly in children consuming multiple processed products is cumulative and combinatorial, a gap only partially addressed in current risk assessment.^{17,21}

Detection and surveillance technology

Rapid, low-cost field-detection tools for common adulterants remain unevenly deployed across states, limiting real time enforcement at point of sale.¹

RECOMMENDATIONS

Regulatory and enforcement measures

Expedite finalisation of a mandatory, interpretive front-of-pack warning system (rather than a purely numeric panel), consistent with the direction indicated by the Supreme Court and aligned with FSSAI's own 2022 high fat sugar salt (HFSS) threshold definitions.^{13,31}

Increase the number of trained food safety officers and NABL-accredited testing laboratories, with priority deployment in states showing the highest non-conformance rates.³

Strengthen risk-based, unannounced inspection of unregistered and small-scale food businesses, which account for a disproportionate share of adulteration and mislabeling.^{1,3}

Label design and communication

Mandate multilingual (regional-language) labelling of key safety and additive information on mass-market products, not only English.

Adopt simplified, colour-coded, or symbol-based preservative and additive risk communication, analogous to traffic-light nutrient labelling, rather than relying solely on INS numbers.

Require minimum font-size and contrast standards for additive and allergen declarations specifically, given documented complaints about illegibly small print.⁴

Public health and consumer literacy

Integrate food label literacy, including preservative and additive interpretation, into school health curricula and community health worker (ASHA/Anganwadi) outreach materials.

Engage healthcare professionals' physicians, dietitians, and pharmacists as trusted intermediaries for translating label information into practical dietary guidance, particularly for patients managing chronic conditions.

Use targeted public-awareness campaigns addressing the specific finding that most consumers do not perceive mislabelling as a health risk, rather than assuming awareness alone will drive behaviour change.³⁵

Research and technology

Support Indian context research on cumulative, multi-additive exposure in children, given the international evidence base linking combined dye and preservative exposure to behavioural effects.²⁵

Encourage adoption of QR code linked digital labelling and block chain-based traceability pilots to supplement, not replace, physical label disclosure, particularly for supply-chain-verified preservative and origin information.

CONCLUSION

Food preservatives remain a technologically necessary and, within regulatory limits, broadly safe component of India's food supply. The threat to Indian public health documented in this review arises less from the mere

presence of permitted preservatives than from three compounding factors: documented patterns of adulteration and non-compliance concentrated in low-cost and unorganised-sector products; a labelling regime that is technically comprehensive but not yet interpretively accessible to the majority of consumers; and consistently low functional literacy around what preservative and additive information actually means for health. Closing this gap will require coordinated action an interpretive front-of-pack warning system, strengthened enforcement capacity, simplified and vernacular label design, and sustained public health-literacy investment so that the legal right to information already guaranteed under India's food safety regulations translates into a practical, exercisable right for every consumer, regardless of education or income.

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