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Food Safety and Standards Digest

SCIENCE – POLICY – PRACTICE – AWARENESS

FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA
FDA Bhawan, Kotla Road, near Bal Bhawan, New Delhi-110002, India

About

The Food Safety and Standards Digest (FSSD) is a biannual publication by the Food Safety and Standards Authority of India (FSSAI).

It shares science-based information and raises awareness about food standards and safety among stakeholders, including food business operators, the scientific community, and consumers.

It links stakeholders with technical papers, expert insights, and peer-reviewed research.

Foreword

PUNYA SALILA SRIVASTAVA
CHAIRPERSON FSSAI,
AND SECRETARY, MoHFW, GoI

It gives me pleasure to present the inaugural issue of the Food Safety and Standards Digest. Regulation is most effective when it is transparent and understood by those it regulates. In a vast country like India, the dissemination of accurate, science-based information is a critical pillar of our regulatory framework.

This Digest is envisioned as a strategic tool to fulfil this objective, providing a structured medium to communicate the scientific rationale behind food regulations to the public and stakeholders alike.

I congratulate the editorial team on this initiative and trust that this publication will serve as a consistent channel for disseminating the Authority's vision for a safer food ecosystem.

Preface

RAJIT PUNHANI
CHIEF EXECUTIVE OFFICER, FSSAI

The food sector in India is evolving rapidly, driven by global trade, technological advancements, and changing consumer preferences. In such a dynamic landscape, the effective implementation of food safety norms requires that all stakeholders – from consumers to Food Business Operators to enforcement agencies – possess a current and comprehensive understanding of the regulatory environment.

The Food Safety and Standards Digest is designed to bridge the gap between policy formulation and ground- level awareness. By offering insights into recent notifications, global best practices, and scientific developments, this publication aims to facilitate "informed compliance." It allows the industry to stay stakeholders to stay abreast of the regulatory trends and strengthen their technical knowledge regarding the scientific principles underlying the standards.

I look forward to the Digest becoming a regular reference point for the food safety community and contributing to the technical capacity building of the sector.

Editor's Note

The formulation of food safety standards is fundamentally anchored in science. The Food Safety and Standards Act, 2006, mandates that regulatory decisions be based on a structured risk assessment process.

This Digest serves as a platform to explain the scientific rationale governing standard setting and to address technical complexities, without superseding the Act or Regulations. The publication will focus on knowledge sharing in critical areas, including the troubleshooting of test methods, the application of Certified Reference Materials (CRMs), and the evaluation of emerging technologies and evolving food systems.

By featuring technical case studies and analysis, the Digest aims to support laboratories, researchers, and technical officers in maintaining scientific rigor. We invite the scientific community to utilize this platform to share knowledge and advance the technical capability of India's food safety network.

SHYAM NARAYAN JHA
EDITOR-IN-CHIEF

Advisor's Desk

I am pleased to present the inaugural issue of the Food Safety and Standards Digest (FSSD). This initiative aims to serve as a structured mechanism for stakeholder engagement, linking regulatory developments with scientific discourse.

The Digest is designed to function as a companion to the National Stakeholder Consultations (NSC) Portal. While the NSC Portal provides direct access to draft regulations for official consultation, the Digest offers the necessary context, independent expert perspectives, and coverage of international trends. It is essential to clarify that this journal serves solely as a means of information sharing and does not constitute a legal document. In the event of any discrepancy, the specific provisions of the Food Safety and Standards Act, 2006, and its Regulations shall prevail.

To foster a robust exchange of ideas, we invite peer- reviewed contributions – including reviews, case studies, and research findings – from scientific professionals, legal experts, and academia. Detailed submission guidelines are available on the FSSAI website.

ALKA RAO
EXECUTIVE EDITOR

Editorial Board

FOR THE INAUGURAL ISSUE OF

FOOD SAFETY AND STANDARDS DIGEST

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FOOD SAFETY AND STANDARDS DIGEST

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Food Packaging Contact Materials: An Updated Review

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Abstract

Food contact substances (FCSs) refer to those materials which come into contact with food at some or the other stage of food handling (including processing, packaging, storage, or preparation). This includes materials used throughout the food supply chain, such as processing equipment, adhesives, household utensils, printing inks, coatings, stabilizers, colorants, etc. A major issue that arises when food contact materials (FCMs) come in contact with food material is the migration of the particles of FCMs into food. The modern-day packaging materials such as synthetic polymers, bio-based plastics, multilayer laminates along with recycled materials involve heavy usage of chemicals during its manufacturing or processing. Therefore, these materials contain huge amounts of intentionally added substances (IAS) and non-intentionally added substances (NIAS), which may migrate from these materials into the food product that comes in contact with these materials. The recent studies conducted on over 3,600 chemicals used as FCSs have been found to have negative impacts on the human body. The chemicals have been found to be the endocrine disruptors, metabolic disruptors, and carcinogenic as well. The enhancement in the structural complexity of packaging, leading to the shift of industries towards combined sustainability and recycling, has further added newer challenges, including scientific, analytical, and regulatory. This review summarizes the latest updates on different varieties of FCM, migration pathways, health hazards, latest regulations to administer its usage, and following research thrusts. Based on these studies, the article also highlights the urgent need for a unified global standard, better assessment of NIAS and development of packaging materials which are comparatively safer and innovative.

Keywords: Carcinogenic; Chemical Migration; Food Contact Materials; Packaging Safety; Photoinitiators

1.0 Introduction

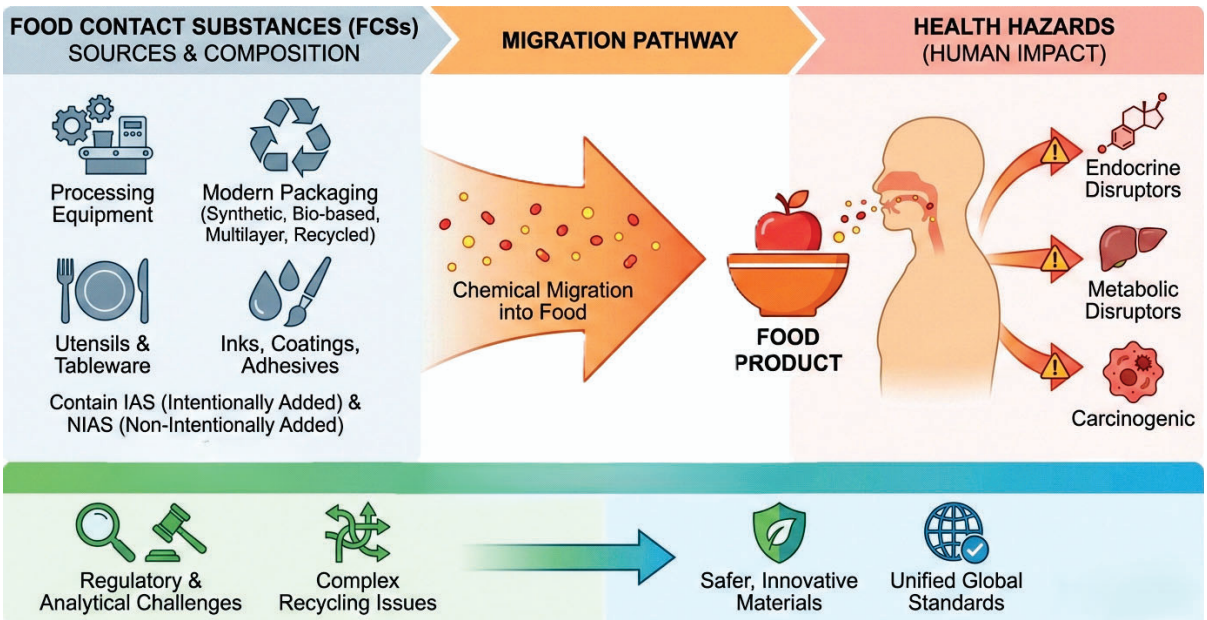
Food packaging is required to store food fresh throughout long durations of time, safeguard food against physical, chemical, and microbial contamination. This has the effect of increasing food shelf life. The food wrapping that comes in contact with the food is a barrier that prevents entry of moisture, air, light, and other degrading elements into a food and contributes to rotting of food. This dichotomy of protection in case of possible contamination is an inherent element that is needed in the ongoing debates concerning the safety of food contact materials (FCMs). The FCMs are those that come in direct or indirect contact with food (Groh et al., 2020). They include plastics, paper & board, metals, glass, ceramics, elastomers, adhesives, inks, and new options including bio-based polymers and recycled plastics. These materials have a wide range of chemical compounds, such as monomers, oligomers, plasticizers, stabilizers, colorants, catalysts, and

processing aids. The way these chemicals get into food depends on the chemistry of the packaging, the environment, the qualities of the food, how long it is stored, and the temperature.

These packaging materials harbor various constituent chemicals - monomers, stabilizers, plasticizers, colorants, and processing aids, which can seep out into the food. The rate at which this migration occurs hinges critically on factors such as the packaging's chemical composition, ambient storage temperature, the food's specific properties, and the overall duration of contact. Driven by how we consume products today, packaging technology has evolved rapidly. We now see everything from multilayered laminates and nanocomposites to "smart" active packaging and compostable films. While these breakthroughs make packaging much more functional, they also introduce a new wave of potential "migrants" - chemicals that leak into our food. This includes non-intentionally added substances (NIAS), which are essentially accidental byproducts created during manufacturing, recycling, or chemical degradation (Thoden et al., 2023).

The rise of modern consumer habits has led to the creation of innovative packaging technologies such multilayer flexible laminates, nanocomposites, high-barrier coatings, active and intelligent packaging, biodegradable films and recycled polymer systems. These new ideas make things work better, but they also bring in new potential migrants, such as unknown NIAS that arise through degradation, manufacturing processes, impurities, and recycling pollutants. Recent (2024) biomonitoring investigations detected more

Fig 1: Migration of Food Contact Substances in Food



than 3,600 food-contact-related compounds in human blood, urine, and serum (Fig 1). Phthalates, bisphenols, mineral oil hydrocarbons, photoinitiators, amines, and oligomers are all linked to endocrine problems, reproductive damage, cancer, metabolic problems, and neurotoxicity. This scary evidence has made calls for better testing methodologies, revised rules, and clearer risk assessment frameworks even stronger.

2.0 Types of Materials Used in Food Contact Applications

There are thousands of materials used for packaging and processing food worldwide. The safety of these materials depends on the chemicals they are made of and how easily their parts can move about.

3.0 Migration Mechanisms

Migration refers to the movement of chemicals from FCMs into food. It occurs by a combination of both physical and chemical processes; these may include diffusion, partitioning, evaporation, and penetration. The primary mechanism by which things occur is diffusion and is exerted wholeheartedly by items such as

Table 1: Types of Materials Used in Food Contact Applications

Category	*Examples*
Plastics / Polymers	PE, PP, PET, PVC, PS, PC, Nylon, EVOH, ABS, etc
Paper & Paperboard	Kraft paper, parchment paper, paperboard, molded fiber
Coated & Laminated Paper	PE-coated paper, aluminum-coated, biopolymer-coated
Metals	Aluminum, tinplate, stainless steel
Glass	Soda-lime glass, borosilicate glass
Ceramics & Porcelain	Glazed ceramics, stoneware
Elastomers / Rubbers	Silicone, nitrile rubber, EPDM, natural rubber
Biodegradable Biopolymers/ Compostable	PLA, PHA, starch-based polymers, cellulose films
Composites / Multilayer Materials Textiles	Plastic-plastic laminates, plastic-aluminum, paper–plastic Cotton, synthetic fibers
Inks, Coatings &	UV inks, solvent-based inks,
Adhesives	Lacquers, epoxy coatings, laminating adhesives
Wood & Bamboo	Untreated or treated wood, bamboo composites

the molecular structure of the polymer, the size and polarity of additions, the level of crystallinity and external factors such as temperature and the duration things are in contact with one another. Temperature is also a very significant variable; a slight increase in it can significantly accelerate the flow of molecules in the substance, accelerating the rate of migration.

Partition coefficients determine the distribution of a substance when it diffuses out of the material, and it is between the FCM and the food matrix. These coefficients tell us how the migrant divides into two phases at equilibrium. This partitioning is highly dependent on the composition of the meal. The lipophilic (fat-loving) substances are more readily absorbed into fatty foods, and consequently, plasticizers, antioxidants and other additives that are hydrophobic relocate more. Conversely, watery or acidic meals are likely to get hydrophilic substances, such as some monomers or ionic degradation products (Groh et al., 2020).

The latest scientific researches have contributed to the improved understanding of the migration processes and have identified multiple new avenues beyond the mechanisms of diffusion, which are controlled by the diffusion. Migration is of many varieties, such as set-off migration, which occurs when the chemicals migrate between printed or coated surfaces when materials have been stacked or rolled, gas-phase migration, when volatile compounds move through the headspace without contact, migration by contact condensation, when water droplets or steam dissolve to carry migrants to the food, and migration through multilayer structures, when substances move through barrier layers previously understood to be impermeable. All these findings underscore the complexity of migratory behavior and the need to have sophisticated analysis methodologies to the modern food packaging system (Begley, 2020).

4.0 Analytical Methods for Identifying and Quantifying Migrants

To locate FCM migrants, especially NIAS, you need powerful analytical tools. Overall migration considers the total amount of non-volatile chemicals that are transferred in the food simulants. GC-MS, HS-GC, HPLC-MS/MS, UHPLC-QTOF-MS, and ICP-MS are all tests for specific migration. Recent (2025) investigations have identified benzene derivatives, amines, nitrites, and oligomers in packaged goods, thus underlining the diversity of contaminants. The NIAs are derived from things such as impurities, byproducts, deterioration, and pollutants that are recycled. It is hard to find them because we do not know what it is, and there are no standards and there is no sufficient or enough toxicological data. To fill these gaps, high resolution mass spectrometry and non-targeted screening are being used in recent times (Nerín et al., 2023).

5.0 Regulatory Frameworks

The FCMs have a lot of regulations, worldwide, and they exist to ensure the safety of people. Nonetheless, these regulations differ greatly across regions of the world, as follows:

5.1 European Union (EU)

The European Union operates one of the most comprehensive and science-based frameworks for food contact materials. The cornerstones of EU regulations are:

- Framework Regulation (EC) No 1935/2004 – Establishes general safety principles for all materials and

articles intended to come into contact with food.

- Requires that materials do not transfer constituents to food in quantities that could endanger human health, change food composition, or alter sensory qualities.
- Mandates traceability and labeling throughout the supply chain.

This regulation is supported by more specific measures, including:

- Commission Regulation (EU) No 10/2011 - Governs plastic materials and articles, providing a positive list of authorized substances, specific migration limits (SMLs), and overall migration limits (OMLs).
- Regulation (EC) No 2023/2006 - Establishes Good Manufacturing Practice (GMP) requirements for all FCMs.
- Specific Directives or Measures - Cover materials such as regenerated cellulose film (2007/42/EC), ceramics (84/500/EEC), active and intelligent packaging (450/2009), and recycled plastics (2022/1616).

5.2 United States

In the United States, the Food and Drug Administration (FDA) regulates FCMs under the Federal Food, Drug, and Cosmetic Act (FD&C Act). Key regulatory mechanisms include:

- Title 21 of the Code of Federal Regulations (CFR) – Lists authorized substances for specific material categories (e.g., 21 CFR 177 for polymers, 21 CFR 175 for adhesives, and 21 CFR 178 for adjuvants and production aids).
- Food Contact Notifications (FCN) - Allow manufacturers to obtain FDA clearance for new substances used in FCMs. Once an FCN is approved, it applies exclusively to the notifier and specific conditions of use.
- Threshold of Regulation (ToR) exemptions - Permit use of substances with negligible migration and risk.
- Good Manufacturing Practices (21 CFR 174.5) - Mandate sanitary and safe production conditions for all food contact articles.

The US approach is substance-based and relies heavily on toxicological evaluation, exposure assessment, and migration modelling. It provides flexibility for innovation, but places responsibility on manufacturers to ensure safety under intended use conditions.

5.3 Canada

Health Canada's Food Directorate regulates FCMs under the Food and Drugs Act. While Canada has no single comprehensive list equivalent to the EU's positive list, it maintains an internal database of reviewed and approved substances. Manufacturers may voluntarily submit pre-market notifications to obtain safety evaluations for new materials. Canada's approach aligns closely with the USFDA model and recognizes many FDA clearances as supportive evidence.

5.4 Asia-Pacific Region

The Asia-Pacific region includes, both harmonized systems and developing frameworks:

5.4.1 China

The National Health Commission (NHC) administers a well-defined system under:

- GB 4806.1-2016: General safety standard for FCMs.
- GB 9685-2016: Positive list of additives for food contact materials.
- GB 4806.7-12: Series for specific materials such as plastic, paper, rubber, and coatings.
- Compliance involves meeting migration limits, labeling requirements, and local testing.

5.4.2 Japan

Governed by the Food Sanitation Act, amended in 2020 to introduce a positive list system for synthetic resins, aligning Japan more closely with EU and FDA approaches. Testing and documentation are required for all new materials.

5.4.3 India

Food Safety and Standards Authority of India (FSSAI) oversees packaging safety under the Food Safety and Standards (Packaging) Regulations, 2018, covering plastics, metals, glass, paper, and multilayer laminates.

5.5 Latin America

Regulatory systems in Brazil, Mexico, Argentina, and Chile are based largely on Mercosur Resolutions, particularly:

- Mercosur GMC Resolution No. 03/92 - General principles for FCMs.
- Mercosur GMC Resolution No. 32/07 - Technical regulation for plastic materials and articles.

These are harmonized with EU and FDA concepts, including positive lists and migration testing requirements. Brazil's ANVISA enforces compliance at the national level.

As indicated above, Plastics Regulation (EU) No. 10/2011 is more detailed on what is permitted and what is not permitted with a list of approved compounds, maximum level of migration, tests, and multilayer specifications. Recently, this has become more difficult due to the increasing concerns with the use of substances that are increasingly of concern, such as styrene, the bisphenol analogues (such as BPA, BPS and BPF), titanium dioxide nanoparticles, and printing inks chemicals. The reason behind this is that the emerging scientific studies are proving that such substances could be harmful.

The United States government has numerous means by which the USFDA monitors FCSs. The Food Contact Notification (FCN) program allows individuals to verify the safety of new compounds before the market. Rules on indirect additives are contained in Title 21 CFR, and there are exemptions of Threshold of Regulation (TOR) concerning items that are very unlikely to be exposed. This dynamic, risk-based framework has allowed the sector to have a great deal of accountability to demonstrate that novel concepts are secure.

The Bureau of Indian Standards (BIS) and the Food Safety and Standards Authority of India (FSSAI) are the two major bodies that ensure that regulations are adhered to in India. The FSSAI establishes a threshold of the total migration, particular migration of heavy metals, primary aromatic amines, phthalates, and monomers. The BIS, conversely, formulates standards for plastics and polymeric materials used in packaging, printing inks standards, such as prohibition of toluene-based inks and unfortunate colorants. The regulatory framework in India is being upgraded to global standards. Although considering realistic scenarios, demographic diversity across rural and urban areas in Indian context, there are challenges to implement enforcement.

The most significant issue that affects all states is the occurrence of NIAS compounds that enter the material accidentally as an impurity or as the byproduct of reaction or degradation or in recycled feedstock. The NIAS are not easy to address, because many cases cannot be fully identified or measured using the current specific analytical methods. Experts recommend that hazard identification and risk assessment should be conducted at the level of the entire material rather than those known individual substances. The reason is that toxicity may arise with known and unknown chemicals and the combination of mixtures may be synergistic or cumulative.

On the global arena, international fragmentation remains a huge issue to the safe international trade and uniform compliance and in view of different technical barriers to trade (TBT) notifications by countries. Manufacturers operating in more than one market are not sure of what to expect, due to the variance in substance authorization list, circumstances of migration testing, NIAS standards, and recycled plastics criteria. Although Codex Alimentarius and industry associations are being involved in it, still no global standards of FCMs can be found that are identical across the board. It is particularly the case with NIAS, recycling or chemical upcycling of advanced materials, and polymers. This demonstrates the significance of having safety frameworks that work across borders and regulatory science working across borders (Franz & Welle, 2022).

6.0 Potential Migrants and Health Concerns

Numerous scientific sources are proving that numerous chemicals contained in FCMs are not only known to be harmful but becoming known to be harmful, which casts doubt on the safety of the consumers. Some of the most studied migrants are plasticizers, especially phthalates. They are applied to make the polymers more flexible. Much of the toxicology study revealed that they have the capacity to interfere with hormonal signalling to disrupt the normal functioning of hormones and impair reproductive development and metabolic diseases. Several of the more risky phthalates have been stricter or even banned by regulatory agencies

across the globe, but remain because of antique materials, incidences of cross-contamination, and the use of alternative plasticizers, the safety profile of which is not fully known.

Another large category of items that concerns people is bisphenols, which is utilized in polycarbonate plastics, epoxy can finishings and thermal papers. BPA, BPS, BPF, and other structural equivalents are also examples of bisphenols. They are associated with reproductive diseases, neurodevelopmental effects, immune system alteration and potential metabolic changes such as obesity and diabetes as these substances contain estrogenic and anti-androgenic qualities, assuming the role of hormones and inhibiting them. Although much criticism and restriction has been placed on BPA, its substitutes which are often marketed as BPA-free are now showing the same endocrine-disrupting properties. This exhibits a process of ill substitution.

Mineral oil hydrocarbons (MOH) are another complicated collection of pollutants that can come from inks, adhesives, recycled cardboard, and lubricants used in processing. In this group, mineral oil aromatic hydrocarbons (MOAH) are especially worrisome since some parts of them may induce mutations or cancer, and there is proof that they build up in human tissues such the liver, spleen, and lymph nodes. Even if regulators are paying more attention to MOH, it is still hard to analyze them because their compositions are so complicated. Photoinitiators, which are used in UV-cured printing inks and coatings, can also be harmful to health. Several frequently utilized photoinitiators have been recognized as genotoxic, cytotoxic, or endocrine-active, and exhibit a tendency to move into food, particularly under insufficient curing conditions or when utilizing low-barrier materials such as paper and thin films. High-profile cases involving 4-methylbenzophenone and ITX have shown that there are holes in the control mechanisms and that printing processes need to be watched more closely.

The most difficult group is NIAS, which includes a huge number of impurities, degradation products, chemical intermediates, oligomers, and contaminants that come from raw materials, additives, or recycling processes. Researchers have found thousands of unknown compounds in blood, urine, and tissues thanks to improvements in analytical chemistry and human biomonitoring. Many of these chemicals may come from food packaging and other things we use daily. Because we do not know much about NIAS, we do not know much about their toxicological profiles, interactions, or cumulative effects. This makes typical risk assessment methods very difficult. These results show how difficult it is to figure out how safe chemicals are in FCMs, and they stress the need for more toxicological tests, better analytical methods, and stricter rules.

7.0 Conclusion

Safety concerns have been compounded by rapid changes in packaging technology and the need to be environmentally friendly. Recycled and bio-based materials will be more environmentally friendly, but they usually generate more NIAS due to plant pollutants, byproducts of fermentation, and old toxins. Few of the 12,000 or so known food-contact compounds have been rigorously tested for toxicity. Many testing labs lack the high-resolution mass spectrometry that is required to make a robust NIAS evaluation. The primary issues include the fact that NIAS standard is not rigid enough, International SMLs are not universal, and a control over e-commerce packaging is also ineffective. The FAO (2024) recommends an all-inclusive approach that considers human health, environmental effects, microplastic pollution, and the environmental impacts of packaging chemicals.

Table 2: Migration Limits

Parameter	*Limit*
Overall Migration (OML)	10 mg/dm² or 60 mg/kg
BPA (SML)	0.05 mg/kg
Phthalates (SML range)	0.3–1.5 mg/kg
PAAs	0.01 mg/kg (or ND for carcinogens)
Heavy Metals (Pb)	< 0.01 mg/kg
VCM	0.01 mg/kg
TOR Exposure Limit	0.5 µg/person/day

Chemical migration of FCMs continues to be a significant food safety issue in all parts of the world. The regulatory frameworks are essential to safety and the introduction of new materials, sustainability, and improved container designs complicate everything significantly. The discovery of thousands of chemicals related to packaging in human biomonitor specimens demonstrates the significance of the presence of the updated regulatory procedures, improved analysis techniques,

and safer materials design.

Future goals are the development of non-targeted analytical methods, NIAS rules are to be more powerful, global harmonization is encouraged, computational toxicology is used and the cooperation between industry, researchers and politicians is promoted in the world. The health of consumers will be at risk and new materials science, analytical chemistry, and food safety regulations will be necessary together with the coordinated efforts on the global level.

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Spices: A Guide to Types, Benefits, Uses and Safety Concerns

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Abstract

India, the world's largest producer and exporter of spices, contributes significantly to the global spice industry. Spices, derived from various plant parts, offer diverse flavors and potential health benefits due to their bioactive compounds. Consumers can maximize their culinary and health experiences by understanding spice varieties, forms, and proper storage methods. The food industry utilizes spices for their functional properties, including preservation, coloring, and antimicrobial capabilities. Spices are gaining prominence as natural preservatives, offering an alternative to synthetic additives. However, the spice industry faces challenges related to food safety and authenticity, particularly due to economically motivated adulteration.

1.0 Introduction

India, known as the '***Land of Spices***', is the world's largest producer, consumer, and exporter of spices. Spices are among humanity's oldest and most esteemed treasures, encompassing dried seeds, fruits, roots, bark, leaves, and other plant components primarily utilized for flavoring, coloring, or preserving food. Throughout history, spices have played a pivotal role in global trade, cultural practices, and culinary traditions, with their influence extending far beyond the kitchen into traditional medicine and therapeutic applications. The term "spice" itself derives from the Latin word "species," signifying merchandise or wares, underscoring their historical value as commercial goods. Historically valued for their medicinal properties, spices remain integral to both Indian heritage and global health-conscious markets.

Presently, the global spice industry continues to thrive, with Asia accounting for nearly 70% of worldwide production and imports of herbs and spices. India cultivates over 60 varieties out of the 109 spices recognized by the International Organization for Standardization (ISO). The spice sector contributes approximately 9% to India's total agricultural exports and over 40% of horticultural exports. With a global footprint spanning over 200 countries, India exports 225+ unique spice products, reinforcing its position as a trusted global supplier of both raw and value-added spices (PIB, 2025). The top 10 destinations of export from India are China, USA, UAE, Bangladesh, Thailand, Malaysia, UK, Saudi Arabia, Indonesia, and Germany, collectively accounting for over 60% of total export earnings in FY25 (until February 2025). During the financial year 2023–24, chilli emerged as the leading spice exported from India, with a total export value of USD 1,508.94 million. It was followed by cumin and spice oils and oleoresins, which recorded export values of USD 700.23 million and USD 498.01 million, respectively. Other notable exports included mint products, turmeric, and curry powders/paste, each contributing significantly to the overall export volume. In 2023–24, Madhya Pradesh led India's spice production with 3.63 million tonnes, followed by Gujarat with 1.29 million tonnes

and Andhra Pradesh with 1.28 million tonnes. Rajasthan and Telangana also made significant contributions, producing over 1 million tonnes and 793,000 tonnes, respectively. These top five states play a crucial role in sustaining India's leadership in the global spice market (PIB, 2025). This comprehensive overview aims to equip consumers with in-depth knowledge regarding spice varieties, their potential health benefits, available forms, industrial applications, and critical safety considerations, thereby enabling informed decision-making and enhanced culinary experiences.

Table-1: Spices and their specific usage

Spices	*Specific Usage*
Cardamom, cinnamon, nutmeg, mace, allspice, fennel, cumin, marjoram	Flavour
Coriander, onion, garlic, clove	Deodorant
Black pepper, chilli, ginger, mustard, Sichuan pepper	Pungency
Turmeric, paprika, saffron	Colour
Cinnamon, cardamom, ginger, chilli, mustard, turmeric	Preservative

2.0 Diverse Varieties and Types

Spices can be categorized based on the plant part from which they are derived, each contributing distinct aromatic profiles, flavors, and chemical compositions (Table 1). Understanding these categories enables consumers to make informed selections and utilize spices effectively in their culinary practices. Bulbs and roots, such as garlic, ginger, and turmeric, constitute one significant category, renowned for their pungent flavors and potent bioactive compounds. Seeds represent another major category, encompassing mustard, cumin, coriander, and fennel. These spices are typically dried and often toasted to release their essential oils. Barks include one of the most popular spices globally, cinnamon, harvested from the inner bark of several tree species belonging to the genus *Cinnamomum*. Flowers and flower buds provide spices like cloves and saffron, the latter being among the most expensive due to its labor-intensive harvesting process. Fruits and berries encompass a wide range of common spices, including chili peppers, black pepper, allspice, and vanilla. Global spice diversity reflects regional agricultural practices and culinary traditions. The geographical distribution underscores how climate, soil conditions, and cultural heritage have influenced the cultivation and utilization of various spices across different continents, resulting in the diverse flavor profiles that characterize world cuisines today.

3.0 Potential Therapeutic Benefits

Beyond their culinary applications, spices possess a remarkable array of health-promoting properties, primarily attributed to their abundant concentrations of bioactive compounds such as polyphenols, flavonoids, terpenoids, and sulfur compounds. These substances contribute to the antioxidant, anti-inflammatory, antimicrobial, and digestive benefits associated with regular spice consumption (Table 2). Contemporary scientific research continues to substantiate many traditional uses of spices in healing systems like Ayurveda and Traditional Chinese Medicine, elucidating mechanisms through which these plant-derived substances positively impact human physiology.

The synergistic effects of combining spices warrant particular attention. Research indicates that employing multiple spices in combination can yield more potent health benefits than when used individually. For instance, combining turmeric with black pepper significantly enhances the absorption of curcumin, turmeric's primary active compound. Similarly, Mediterranean herb blends incorporating oregano, rosemary, basil, and thyme exhibit enhanced antimicrobial effects compared to individual herbs. This synergistic principle underpins many traditional spice blends worldwide, from Indian curry powders to Italian herb mixtures, suggesting that culinary traditions have intuitively recognized the enhanced benefits of spice combinations long before scientific validation.

It is imperative to maintain a balanced perspective regarding spices and health. While spices can support wellness and potentially reduce disease risk, they should not be regarded as standalone treatments for serious health conditions. The scientific evidence supporting health benefits varies considerably among spices, with some having robust clinical trial support and others relying primarily on traditional use and preliminary studies. Consumers should perceive spices as valuable components of a holistic approach to health rather than as medicinal solutions, and individuals with specific health conditions should always consult healthcare providers regarding significant dietary modifications or therapeutic applications.

Table-2. **Major spices, their bioactive compounds and their health benefits**

Spice	*Major Bioactive Compounds*	*Major Health Benefits*
Turmeric (*Curcuma longa*)	Curcumin, Demethoxycurcumin	Anti-inflammatory; anticancer; cardioprotective; hepatoprotective; neuroprotective; anti-diabetic; anti-cataract
Clove (*Syzygium aromaticum*)	Eugenol	Anti-inflammatory; antimicrobial; anticancer; cardioprotective; hepatoprotective; radioprotective
Black Pepper (*Piper nigrum*)	Piperine	Anti-inflammatory; anticancer; improves lipid metabolism; enhances nutrient bioavailability
Red Chili (*Capsicum* spp.)	Capsaicin, Carotenoids	Anti-inflammatory; anti-obesity; cardioprotective; anticancer; analgesic
Ginger (*Zingiber officinale*)	Gingerol, Shogaol, Zingerone	Anti-inflammatory; antiemetic; anticancer; antidiabetic; cardioprotective; gastroprotective
Garlic (*Allium sativum*)	Allicin, Diallyl sulfides, S-allyl cysteine	Anti-cancer; cardioprotective; anti-diabetic; hepatoprotective; antimicrobial; immune support
Onion (*Allium cepa*)	Quercetin, Organosulfur compounds	Anti-inflammatory; antihypertensive; antidiabetic; anticancer; cardioprotective
Fenugreek (*Trigonella foenum-graecum*)	Polyphenols, Flavonoids, Saponins	Anti-diabetic; hypolipidemic; anti-inflammatory; hepatoprotective
Cinnamon (*Cinnamomum verum*)	Cinnamaldehyde, Procyanidins	Anti-diabetic; antimicrobial; anticancer; cardioprotective
Coriander (*Coriandrum sativum*)	Linalool, Phenolic acids	Anti-inflammatory; antihyperglycemic; digestive health; antimicrobial
Cumin (*Cuminum cyminum*)	Cuminaldehyde, Terpenes, Flavonoids	Anti-inflammatory; anti-diabetic; antimicrobial; digestive stimulant
Cardamom (*Elettaria cardamomum*)	Terpenoids, Flavonoids	Gastroprotective; cardioprotective; anti-inflammatory; anti-cancer
Black Cumin (*Nigella sativa*)	Thymoquinone	Anti-inflammatory; anti-cancer; hepatoprotective; neuroprotective
Mustard (*Brassica* spp.)	Glucosinolates, Isothiocyanates	Anticancer; anti-inflammatory; antimicrobial; cardioprotective

Adapted from *Gupta (2010); Srinivasan (2014); Sharangi (2018); Jiang (2019)*

4.0 Available Forms and Proper Storage

Spices are available in various distinct forms, each exhibiting unique flavor profiles, potency levels, and culinary applications. For the food industry they are available as whole spices, ground powders, essential oils, oleoresins, spice blends, extracts, and encapsulated forms. Understanding these forms enables consumers to make appropriate selections based on their cooking requirements and preferences. Whole spices, such as peppercorns, cinnamon sticks, and cumin seeds, represent the least processed form. These retain their volatile oils and flavor compounds more effectively than processed counterparts, resulting in a longer-lasting aroma and taste. Ground spices offer convenience and facilitate easier incorporation into dishes, but they have a larger exposed surface area, leading to quicker oxidation and flavor loss within a few months. Fresh herbs and spices, including ginger root, fresh turmeric, and leafy herbs, provide vibrant, nuanced flavors but have limited shelf lives. Encapsulated oils and extracts represent more specialized forms that concentrate the bioactive compounds of spices, often utilized for therapeutic purposes.

Proper storage is essential for preserving flavor, aroma, and nutritional integrity. Spices should be stored in opaque, airtight glass containers or tins placed in a cool, dark cupboard, away from heat sources such

as stoves or other heat sources, as heat rapidly degrades their antioxidant components. For spices used infrequently, freezing in airtight containers provides excellent preservation, although frozen spices should be brought to room temperature before opening to prevent condensation. Ground spices typically maintain optimal flavor for 3-6 months, while whole spices can retain quality for up to a year. Regularly dating purchases and conducting occasional "sniff tests" help ensure spices have not lost their characteristic pungency. Adhering to these storage practices enables consumers to maximize both the culinary and health benefits of their spice collections.

5.0 Applications in the Food Industry

The food industry utilizes spices for various purposes beyond mere flavor enhancement. These applications leverage the functional properties of spices, including their preservative, coloring, and antimicrobial capabilities. As consumer preferences shift towards clean-label products, spices have regained significance as natural alternatives to synthetic additives, aligning with demands for more transparent ingredient lists and healthier food options. One notable industrial application pertains to food preservation and shelf-life extension. Numerous spices contain compounds with demonstrated antimicrobial properties that inhibit the growth of bacteria, fungi, and other microorganisms responsible for food spoilage. For instance, cloves, cinnamon, and oregano have been shown to prevent the oxidation of fats and oils in food products, thereby extending their edibility. This natural preservative capability originates from bioactive components such as eugenol in cloves, cinnamaldehyde in cinnamon, and thymol in oregano. Research continues to investigate the efficacy of spice extracts and essential oils against specific foodborne pathogens, with the objective of developing effective natural preservation systems that reduce reliance on synthetic antimicrobials. The flavor-enhancing role of spices remains fundamental to processed food development. Spices contribute depth and complexity to food products by stimulating various receptors on the tongue and nose. Beyond basic flavoring, spices serve as natural colorants in numerous applications - turmeric provides a vibrant yellow-orange hue, paprika contributes reddish tones, and saffron imparts its distinctive golden color. Furthermore, spices increasingly function as salt and sugar replacements in reformulated products aimed at addressing health concerns related to excessive sodium and sugar consumption. By providing robust flavor without adding sodium or calories, spices enable manufacturers to create healthier product profiles while maintaining consumer acceptability.

5.1 Emerging applications in new product development, preservation, and packaging

Spices and spice extracts have traditionally been esteemed for their distinctive flavor, aroma, and color. However, recent scientific advancements have unveiled their substantial potential as natural functional ingredients in contemporary food systems. The heightened consumer demand for clean-label, minimally processed foods, along with apprehensions regarding synthetic additives, has propelled interest in spices as natural sources of bioactive compounds. Their burgeoning applications now transcend conventional culinary applications into novel food product development, food preservation, and active food packaging.

In the realm of new product development, spices and their extracts are being incorporated not only for sensory enhancement but also to provide functional health benefits. Phytochemicals such as polyphenols, flavonoids, carotenoids, capsaicinoids, and essential oils exhibit potent antioxidant, anti-inflammatory, and antimicrobial properties. Functional foods enriched with spice extracts, including turmeric beverages, cinnamon-infused dairy products, ginger-based ready-to-drink formulations, and chili-flavored snacks, are increasingly marketed for their nutraceutical appeal. Microencapsulation technologies facilitate controlled release and enhance the stability of sensitive spice bioactives, expanding their application in bakery, dairy, and meat products. Additionally, novel extraction techniques such as supercritical CO_2 extraction, ultrasound-assisted extraction, and green solvents enable efficient isolation of concentrated extracts with standardized bioactive profiles, ensuring consistent functional performance in food matrices.

Spices are gaining prominence as natural preservatives, offering an alternative to synthetic antioxidants and antimicrobials. Extracts from clove, oregano, thyme, rosemary, and cinnamon demonstrate broad-spectrum antimicrobial activity against foodborne pathogens and spoilage organisms, thereby extending product shelf-life. Essential oils rich in compounds such as eugenol, thymol, carvacrol, and cinnamaldehyde inhibit microbial growth, delay lipid oxidation, and prevent rancidity in high-fat foods. Their incorporation into

meat, poultry, seafood, and dairy-based products has resulted in significant improvements in storage stability. Furthermore, synergistic combinations of spice extracts with other natural hurdles, such as organic acids, bacteriocins, and mild heat treatments, enhance their preservative efficacy. Encapsulation technologies and nanoemulsion systems address challenges related to flavor intensity, volatility, and instability, enabling controlled release and improved functional performance.

The incorporation of spice-based bioactive compounds drives the rapid expansion of the food packaging industry. Active and intelligent packaging technologies are being developed using biodegradable films infused with essential oils, oleoresins, and spice extracts. These films serve as natural antimicrobial and antioxidant barriers, reducing microbial contamination and oxidative spoilage while eliminating the need for chemical preservatives. Edible coatings containing turmeric, cinnamon, black pepper, or oregano extracts have demonstrated promising results in preserving the quality of fruits, vegetables, dairy products, and meats during storage. Advancements in nanotechnology enable the incorporation of nano-encapsulated spice-derived compounds into polymer matrices, facilitating controlled migration, enhanced mechanical properties, and extended functional activity. This packaging approach aligns with sustainability goals by replacing petrochemical-based preservatives and synthetic films with biodegradable, bioactive alternatives.

The growing applications of spices and spice extracts underscore their multifaceted role within contemporary food systems. Their incorporation into food formulations, preservation strategies, and packaging systems not only contributes to product safety, shelf-life extension, and sensory enhancement but also aligns with consumer preferences for natural and health-promoting ingredients. Continued research on purification technologies, toxicity assessment, sensory optimization, and regulatory compliance will expedite their adoption in commercial food applications and facilitate the development of innovative, sustainable, and functional food products.

6.0 Concerns of Food Safety and Adulteration

Despite their numerous advantages, spices face significant challenges related to food safety and authenticity. Economically Motivated Adulteration (EMA), commonly known as food fraud, poses a particular concern within the spice industry. The term adulteration is defined as "intentionally tampering with a food product and degrading the quality of the food by adding inferior substances or by removing some valuable ingredient." This practice typically occurs at various stages of the intricate global spice supply chain and can manifest in several forms, including the addition of fillers to augment volume or weight, substitution with inferior ingredients, and chemical adulteration to artificially enhance color (Table 3).

The health implications of spice adulteration can be severe. While most economically motivated adulteration does not pose immediate food safety risks, some instances have resulted in significant public health concerns. Several regulatory agencies worldwide have documented cases of lead poisoning from adulter-

Table-3. **Common Types of Spice Adulteration and Their Impacts**

Type of Adulteration	*Examples*	*Potential Risks*
Addition of Fillers	Adding starch, flour, or other plant material to powdered spices	Economic fraud; potential allergen exposure
Substitution	Selling less expensive spices as more expensive varieties (e.g., saffron bulked with plant stems)	Economic fraud; reduced product efficacy
Artificial Coloring	Adding illegal dyes like Sudan Red or lead-based dyes to chili powder, turmeric, or cumin	Exposure to carcinogens and toxic heavy metals
Undeclared Ingredients	Adding allergens or other substances not listed on the label	Allergic reactions; health risks for sensitive individuals

ated spices and allergic reactions to hidden, substituted ingredients. Several factors contribute to the susceptibility of spices to fraud. Their typically powdered form renders visual detection of adulteration exceedingly challenging. The high value-to-weight ratio of certain spices creates economic incentives for adulteration, while intricate global supply chains with multiple intermediaries provide opportunities for fraudulent activity. Recognizing these vulnerabilities, regulators and industry organizations have implemented various prevention measures. Regulatory agencies employ a combination of routine monitoring, advanced detection technologies (including DNA sequencing and food analytical chemistry), and regulatory actions to combat spice fraud. The food industry utilizes supplier verification programs, rigorous testing protocols, and traceability systems to ensure spice quality and authenticity throughout the supply chain. Consumers can safeguard themselves by purchasing spices from reputable sources, being cautious of unusually low prices for premium spices, and opting for whole spices when feasible, facilitating easier authenticity verification. Furthermore, seeking third-party certifications and supporting companies with transparent sourcing practices can contribute to ensuring spice quality and safety.

7.0 Conclusions

India, the world's largest producer and exporter of spices, contributes significantly to the global spice industry. Spices, derived from various plant parts, offer diverse flavors and potential health benefits due to their bioactive compounds. While spices can enhance culinary experiences and potentially support wellness, they should be viewed as part of a holistic approach to health rather than standalone treatments. Spices, available in various forms like whole, ground, and encapsulated, offer unique flavors and culinary applications. Proper storage in airtight containers away from heat preserves their flavor and nutritional integrity. While spices enhance food flavor and offer natural preservation, concerns about food safety and adulteration persist, prompting regulatory and industry efforts to ensure authenticity and quality.

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Understanding of Different Types of Claims – A Technical Note

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1.0 Introduction

Under Section 18 of the FSS Act, the FSSAI is responsible for protecting consumer health and ensuring fair trade practices. This includes preventing deceptive or fraudulent activities that could mislead or harm the public. Section 16 further empowers the FSSAI to set specific regulations for food labeling, covering areas like health claims, nutritional information, and special dietary uses.

To support these goals, the Food Safety and Standards (Advertising and Claims) Regulations, 2018 were established. These rules ensure that food advertisements are honest and hold businesses accountable for the claims they make, ultimately safeguarding consumer interests.

2.0 What are Nutrition and Health Claims?

A claim is any "message" or "representation" that manufacturers use to suggest that a food has certain qualities. This can include text (like "gluten-free," "apple flavor," or "low fat") and pictures, graphics, and symbols. For example, a product could claim it was 'vegan' on the label whilst another may use an image of the gut which could imply that the product has a positive effect on gut health. Not all claims have strict requirements that need to be followed, and in these cases, whether the claim is permitted comes down to if it is considered misleading under relevant legislation. However, there are specific types of claims (as shown in Fig 1), including nutrition and health claims that have to meet set criteria before being used for a product. But firstly, what exactly do we mean by nutrition and health claims?

- For nutrition claims, the clue is in the name these relate to a specific nutrient (e.g. fat, sugar, protein, fibre) and suggest a beneficial effect (e.g. low fat, sugar-free, source of protein, high fibre)
- For health claims, these go one step further they make a statement that connects a nutrient/food with a positive effect on health (e.g. vitamin D contributes to the normal function of the immune system; plant sterols contribute to the maintenance of normal blood cholesterol levels)

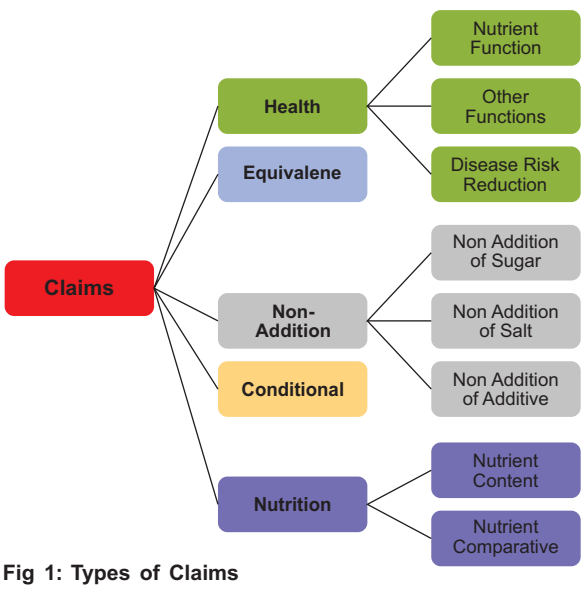

Fig 1: Types of Claims

3.0 How Prevalent are Nutrition and Health Claims?

In 2016, a five-country study in Europe (including the UK) found that out of 2034 food and drinks sampled, 26% had at least one claim; of which, 64% were nutrition claims, and 29% were health claims (Coates et al., 2024). Of the claims, 40% related to processes involved in breaking down food, converting it to energy, and regulating the body's internal environment. Among the five countries studied, the UK had the highest proportion of products with at least one claim (35%).

A study published earlier this year reviewed the prevalence and compliance of products bearing claims online in Great Britain for dairy and alternatives, fruit juices and teas.

In total, 28% of products displayed health claims, although not all claims (6-10%) displayed were compliant with the relevant legislation that is in place to regulate their use (FSSAI, 2018a).

4.0 Concept of A "Claim" in Regulatory Context

A claim is defined broadly as any representation written, oral, audio, or visual that states, suggests, or implies that a food has particular qualities relating to origin, nutritional properties, nature, processing, composition, or other characteristics (FSSAI, 2018b). This expansive definition ensures that not only explicit statements but also implied messages, visuals, and comparative references fall within regulatory oversight.

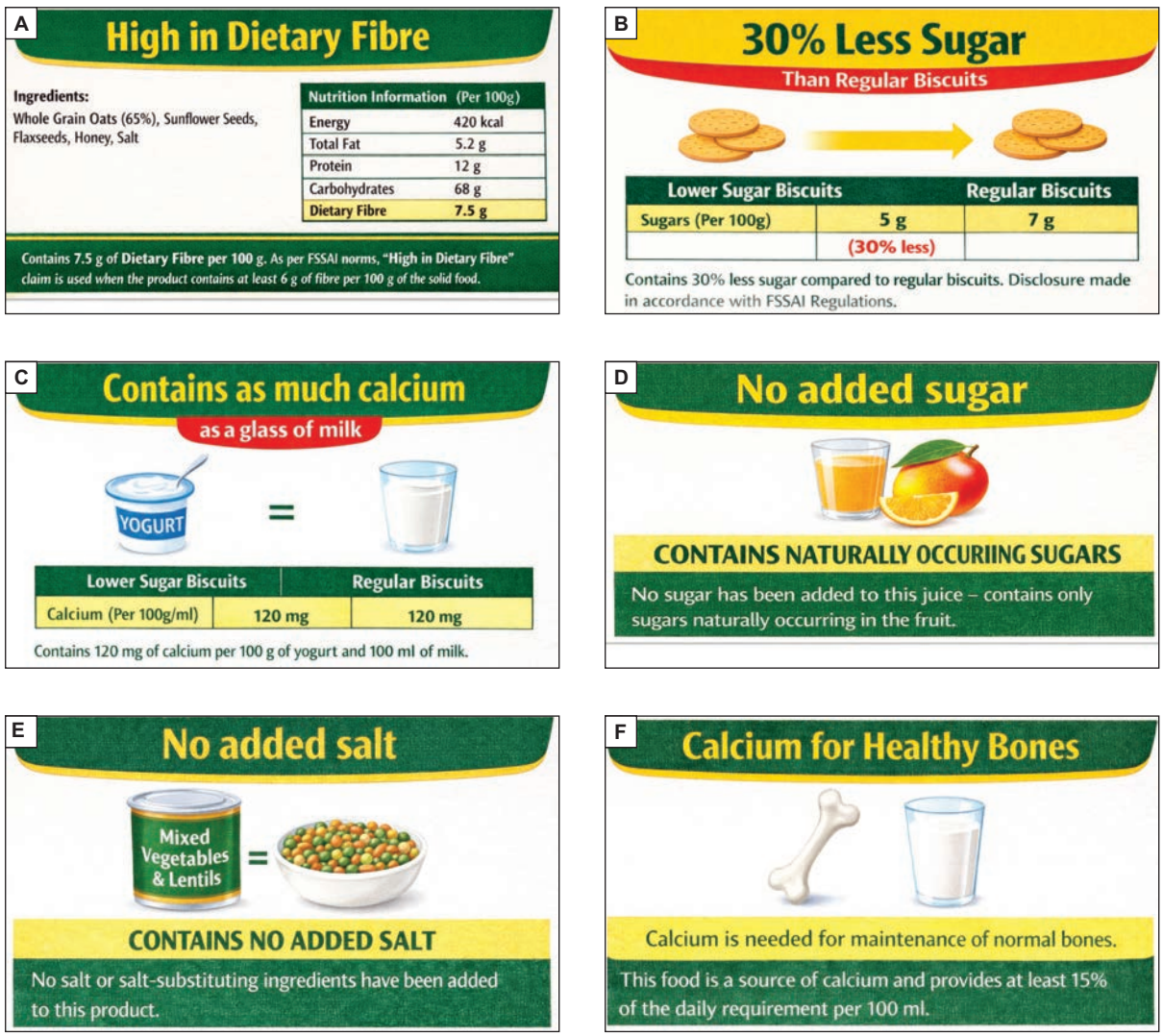

Fig 2: Pictorial representation of various types of claims on labels. A) Nutrient Content Claims, **B**) Nutrient **C**omparative Claims, **C**) Equivalence Claim, **D**) Non-Addition of Sugars, **E**) Non-Addition of Salt, **F**) Nutrient Function Claim

Fig 3: Pictorial representation of other function claims, reduction of disease risk claim and conditional claim

Claims are regulated because they may create health halos, exaggerate benefits, or obscure nutritional risks if not properly controlled. Consequently, the regulations classify claims into distinct types, each with specific conditions and evidentiary requirements.

4.1 Nutrition Claims

Nutrition claims are the most frequent type of claim and are relatively straightforward. According to Regulations 2(1)(l) and 5, these claims focus solely on a food's nutritional properties, such as its calorie count or specific nutrient levels.

4.1.1 Nutrient Content Claims

A nutrient content claim, as shown in Fig 2(A), describes the level of a nutrient present in a food, either directly or indirectly. Examples include "low fat," "high fibre," or "source of protein." (FSSAI, 2018c). It is absolute in nature; no comparison with another food is required and should strictly follow quantitative thresholds specified in Schedule I.

Example:

- "High in dietary fibre" may only be used if the product contains at least 6 g fibre per 100 g (solids).

4.1.2 Nutrient Comparative Claims

A nutrient comparative claim as shown in Fig 2(B), compares the nutrient level or energy value of one food with another similar food (FSSAI, 2018d).

- Comparison must be between similar foods or different versions of the same food.
- Minimum percentage differences are prescribed (e.g., 30% for macronutrients, 10% RDA for micronutrients).
- The reference food and magnitude of difference must be clearly disclosed.

Example:

- "30% less sugar than regular biscuits."

4.1.3 Equivalence Claims

Equivalence claims as shown in Fig 2(C) suggest parity between the nutrient content of two foods (FSSAI, 2018e).

Example:

- "Contains as much calcium as a glass of milk."

Such claims are permitted only if both foods qualify as a source of the nutrient and equivalence is demonstrated on a per-100 g or per-100 ml basis.

4.2 Non-Addition Claims

Non-addition claims communicate the absence of an ingredient or additive that consumers might normally expect in a food (FSSAI, 2018f).

4.2.1 Non-Addition of Sugars

Claims such as "no added sugar" as shown in Fig 2(D) are permitted only when no sugars or sugar-containing ingredients have been added, and sugars have not been generated through processing methods. Where naturally occurring sugars are present, the label must state "CONTAINS NATURALLY OCCURRING SUGARS."

Example:

- Unsweetened fruit juice labelled as "No added sugar – contains naturally occurring sugars."

4.2.2 Non-Addition of Sodium Salts

Claims like "no added salt" as shown in Fig 2(E) are permitted only if no sodium salts or salt-substituting ingredients are used.

4.2.3 Non-Addition of Additives

Claims like "no preservatives added" are only permitted if the additive was not directly included or present in any of the ingredients. Furthermore, businesses cannot use this claim if they have simply replaced a standard preservative with another ingredient that performs the same function.

4.3 Health Claims

Health claims are more complex and stringently regulated because they link food consumption with health outcomes (FSSAI, 2018g)].

Health claims are subdivided into three principal categories.

4.3.1 Nutrient Function Claims

These claims describe the physiological role of a nutrient in normal growth, development, or body functions.

Example:

- "Calcium is needed for maintenance of normal bones."

Such claims as shown in Fig 2(F) must be supported by generally accepted scientific evidence and the food must qualify as a source or rich source of the nutrient.

4.3.2 Other Function Claims

These claims provide specific benefits of foods or their components that go beyond basic nutrition by supporting natural biological or physiological functions as shown in Fig. 3.

Example:

- "Beta-glucans help reduce the rise in blood glucose after a meal."

While these claims do not directly mention reducing the risk of a specific disease, they must be backed by strong scientific evidence to be permitted.

4.4 Reduction of Disease Risk Claims

These claims as shown in Fig 3 suggest that consumption of a food reduces a risk factor for a disease, not the disease itself (FSSAI, 2018h).

Example:

- "Diets low in sodium may help reduce the risk of high blood pressure."

Conditions

- Must not be interpreted as prevention or cure claims.
- Must specify context of total diet and, where required, number of servings.
- Only claims listed in Schedule III are permitted without prior approval.

4.5 Claims Related to Healthy Diets and Dietary Guidelines

Any claims describing food as part of a "healthy," "balanced," or "wholesome" diet must follow the specific

Table 1: DO's and DON'T's to be followed while making claims.	
DO's	**DON'T's**
Truthful, Unambiguous, Meaningful,	Misleading
Help consumers comprehend information	Do not encourage or condone excess consumption of a particular food
Specify the number of servings of the food per day for the claimed benefit	Do not suggest against balanced and varied diets
Claim should be scientifically substantiated by validated methods	No claim on promotion, sale, supply, use and consumption of articles to be made using FSSAI logo
Characterize or Quantify ingredients that is the basis for the claim	Do not undermine healthy lifestyle
All disclaimers to be legible	Advertisements not to portray/promote foods as Meal replacement unless specifically permitted

recommendations outlined in the Indian Council of Medical Research (ICMR) Dietary Guidelines (FSSAI, 2018i).

Importantly, a single food product can never be advertised as inherently "healthy" all by itself.

Example:

- "Part of a balanced diet when consumed alongside fruits, vegetables, and regular physical activity.
- "Health Claim could be: Ingredient Led and Product Led

Probiotics supports good gut health (Ingredient led claim)

- Ingredient led claims may be made based on current relevant scientific substantiation and to provide sufficient evidence on the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data.

Product A supports good gut health (Product led claim)

- Product lead claim shall be based on statistically significant results from well-designed human intervention studies, conducted by or under guidance of established research institutions, in line with the principles of GCP (Good Clinical Practices) and peer reviewed or published in a peer reviewed reputed scientific journal.

4.6 Conditional and Descriptive Claims

Conditional claims include the use of descriptors such as "natural," "fresh," "pure," "traditional," or "original" as shown in Fig. 3 (FSSAI, 2018j).

These terms are strictly defined and permitted only when objective criteria are met.

Example:

- "Made from natural ingredients" (permitted for composite foods, whereas "natural food" is not).

4.7 Prohibited Claims (FSSAI, 2018k)

(1) No claims shall be made which refer to the suitability of the food for use in the prevention, alleviation, treatment or cure of a disease, disorder or particular physiological condition unless specifically permitted under any other regulations made under Food Safety and Standards Act, 2006 (34 of 2006).

(2) There shall not appear in the label of any package, containing food for sale the words "recommended by the medical or nutrition or health professionals" or any words which imply or suggest that the food is recommended, prescribed, or approved by medical practitioners or approved for medical purpose.

(3) No product shall claim the term "added nutrients", if such nutrients have been added merely to compensate the nutrients lost or removed during processing of the food

(4) Foods for special dietary uses or foods for special medical purposes shall not carry a claim unless specifically permitted under any other regulations made under Food Safety and Standards Act, 2006 (34 of

2006).

(5) Claims which do cause doubt or suspicion about the safety of similar food or which may arouse fear shall not be made.

(6) No health claims shall be made for foods that contain nutrients or constituents in quantity that increase the risk of disease or an adverse health-related condition.

(7) No advertisements or claims for articles of foods shall be made by any food business operator that undermines the products of any other manufacturer for the purpose of promoting their products or influencing consumer behaviour.

Comparative Perspective and Regulatory Rationale

The regulatory architecture reflects a graduated risk approach:

- Nutrition claims are low-risk and standardised.
- Non-addition and conditional claims carry moderate risk of consumer misinterpretation.
- Health and disease risk reduction claims pose the highest risk and therefore attract the strictest scrutiny

The general DO's and DON'T's to be followed while making claims have been described in Table 1.

5.0 Conclusion

The Food Safety and Standards (Advertising and Claims) Regulations, 2018 establish a framework for classifying food claims, with each category governed by specific definitions, nutrient limits, and scientific substantiation requirements. Understanding the distinctions between nutrition, health, non-addition, conditional, and prohibited claims is essential for regulators and food businesses. More information is available on the Food Safety and Standards website.

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Nutraceuticals — Overview and Safety Compliances

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Abstract

Nutraceuticals are biologically active ingredients that help maintain optimal health and provide a variety of health benefits. They play a crucial role in disease management and preventive healthcare, and represent a combination of nutrition and pharmaceuticals. Nutraceuticals possess numerous functional properties including cardio protective, anti-inflammatory, anti-diabetic, and other activities. Through Rasayana formulations, traditional systems such as Ayurveda provides foundational concepts that align with modern nutraceuticals. Despite their benefits, issues such as inconsistent product uniformity, adulteration, contamination, and variability in raw materials pose significant safety risks. Furthermore, quality control and safety evaluation are complicated by polyherbal compositions. This article provides an overview of nutraceuticals, their therapeutic applications, safety evaluation, and standardization aspects.

Keywords: Ayurveda; Bioactive compounds; Nutraceuticals; Safety compliance; Therapeutic applications.

1.0 Introduction

India is well known for its traditional medical systems, including Unani, Siddha, and Ayurveda which originated between 2500 and 500 BC, and are described in the ancient Vedic and other classical texts (Pandey et al., 2013). Even today, about 75-80% of the population, especially in developing countries, relies on herbal medicines for primary healthcare because of their better compatibility and acceptability with the human body and fewer adverse effects (Vidyarthi et al., 2013). The growing recognition of the close link between nutrition and health lead to the emergence of the concept of "nutraceuticals," a term coined by Stephen DeFelice, Founder and Chairman of the Foundation for Innovation in Medicine (FIM) in Cranford, NJ, in 1989 by combining "nutrition" and "pharmaceutical" (Keerthika et al., 2025) and defined as food or food components that provides health benefits, including the prevention and treatment of disease (Verma & Mishra, 2016).

From an Ayurvedic perspective, nutraceuticals under the concept of *Rasayana*, which refers to substances that enhance metabolism, immune modulation, and mental health, and overall longevity. Rasayanas are categorised into three classes: *Kamya* (enhancing vitality and intellect), *Naimittika* (targeting specific diseases) and *Ajasrika* (for general daily use) includes *Chyavanaprasha* for respiratory health, *Brahma Rasayana* for mental function, *Phala Ghrita Ksheerapaka* for cardiac function and *Lashuna Ksheerapaka* for cardioprotection (Lamichhane & Pandeya, 2020). Compared with other therapeutic modalities, nutraceuticals are available in capsules, tablets, liquids, and powders have achieved remarkable commercial success and clinically relevant outcomes with reduced side effects. Common example includes

Omega-3-enriched yoghurts, calcium-enriched orange juice and green tea are widely consumed as functional foods, and beverages exhibit therapeutic benefits such as diabetes, cancer, cardiovascular diseases, chronic disorders, neurodegenerative diseases, and other conditions. So, the development of novel ingredients and formulations requires the sustainable and health-oriented utilization of food side streams. Overall, nutraceuticals serve as a vital bridge between food and medicine, offering preventive and supportive strategies against chronic diseases, with strong roots in Ayurveda and supported by growing scientific validation of their therapeutic potential. Overall, this article provides a contextual basis for understanding the importance, classification, and applications of nutraceuticals in modern health and wellness and safety concern and risk factors of nutraceuticals.

2.0 Classification of Nutraceuticals

2.1 Nutraceuticals based on food availability

2.1.1 Traditional nutraceuticals

Traditional nutraceuticals are products that typically originate from natural sources and are consumed in their relatively unmodified form. Examples include omega-3 fatty acids from salmon, saponins from soy and lycopene from tomatoes, which are consumed for their various health benefits.

According to Chanda et al., (2019), traditional nutraceuticals include:

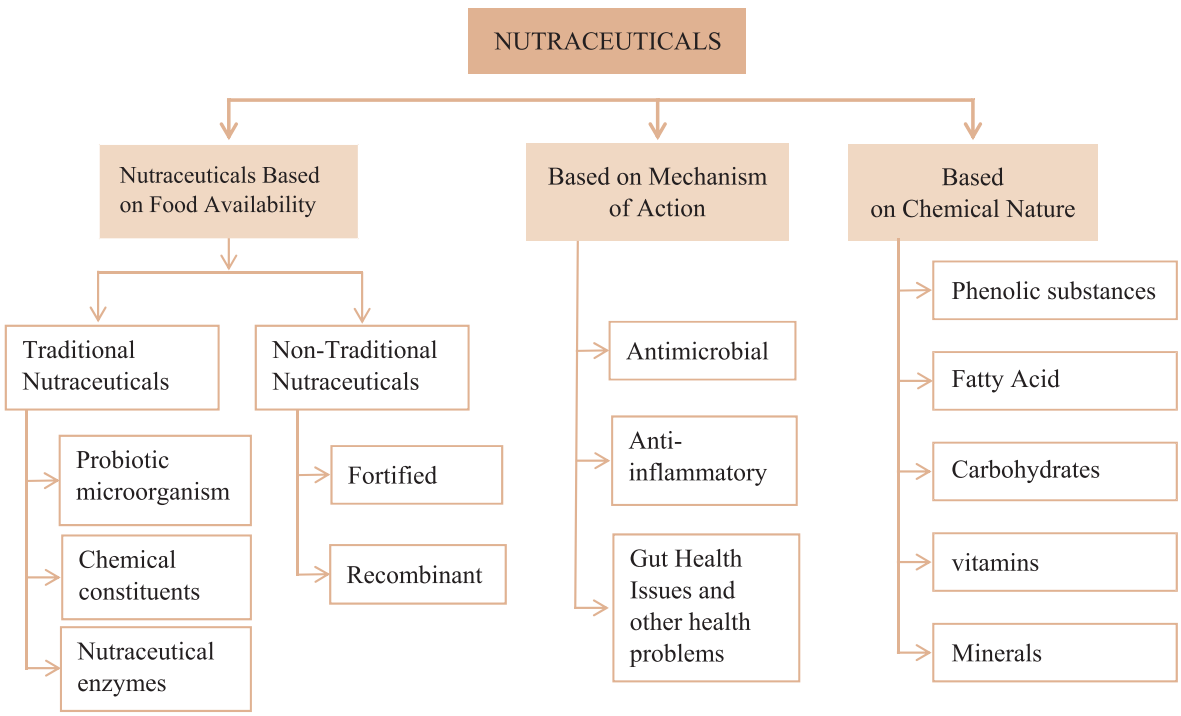
i) Chemical constituents, comprising:

(a) Nutrients: Primary metabolites such as amino acids, vitamins and fatty acids have well-defined roles in metabolic pathways. These combine with vitamins, provide a wide range of health benefits, and help in the management of diseases.

(b) Herbals: Herbal products used as nutraceuticals have a positive impact on the prevention of chronic diseases and the improvement of quality of life. Many herbal sources act as nutraceutical such as saw palmetto berries, cernilton (pollen extract) and other herbal extracts contain â-sitosterols which are beneficial in both acute and long-term conditions.

(c) Phytochemicals: Phytochemicals are plant-derived compounds that support human health through specific biological activities. Many fruits, vegetables, grains, legumes (such as soybeans and chickpeas) and egg yolks contain carotenoids (isoprenoids), which have anti-carcinogenic properties, enhance natural killer cell activity and protect the eyes from UV radiation (Keerthika et al., 2025). Another classic example

Fig 1: Classification of nutraceutical (Adapted from Parasuram Rajam et al., 2019)



is curcumin, the principal bioactive component of turmeric, widely used as a culinary phytochemical.

(ii) Probiotic microorganisms

The term "probiotic" was introduced by Metchnikoff which are essential for enhancing health by reducing harmful bacteria. So, increasingly used in modern medicine to create a healthier gut environment for processes like absorption and metabolism. For example, *Lactobacillus bulgaricus* is beneficial, and many commercially available probiotic products contain such organisms along with nutrients that protect against pathogens and improve health outcomes.

(iii) Nutraceutical enzymes

Nutraceutical enzymes are derived from microbial, animal and plant sources. Enzymes are vital for life, and without them, the body cannot function optimally. Dietary enzyme supplements help alleviate symptoms of conditions such as obesity, digestive disorders and blood glucose imbalance.

2.1.2 Non-traditional nutraceuticals

Non-traditional nutraceuticals are specially designed foods whose nutrient content to improve health. For example, biofortified rice rich in â-carotene and vitamins -enriched broccoli. These foods contain bioactive components deliberately enhanced or added to provide specific health benefits.

They are classified as:

Fortified nutraceuticals: These involve nutrient enhancement through biofortification or processing. For example, minerals-fortified cereals with calcium, iron, and folic acid; and milk can be enriched with cholecalciferol, commonly used in the management of vitamin D deficiency

Recombinant nutraceuticals: These use biotechnological techniques to improve the nutritional and functional properties of foods by producing therapeutic enzymes or other functional components.

2.2 Nutraceuticals-based on mechanism of action

Nutraceuticals can also be classified based on their specific therapeutic properties, such as anti-inflammatory, antimicrobial and antioxidant effects.

2.3. Nutraceuticals-based on chemical nature

These are classified according to their primary and secondary metabolites. Major categories include phenolic substances, isoprenoid derivatives, carbohydrate- and amino acid–based substances and fatty acids.

Polyphenols & Flavonoids: Polyphenols are widely distributed plant compounds, with over 8,000 identified, known for immune support and gene expression modulation (Faienza et al., 2024). The most common group of polyphenols is Flavonoids that includes catechins, thearubigins, theaflavins and isoflavones have potential to cure various diseases.

Alkaloids: Alkaloids are nitrogen containing secondary metabolites mainly of plant origin and biosynthesized from aromatic amino acids via the shikimate pathway, which exhibit therapeutic properties.

Vitamins and minerals: Vitamins are essential organic micronutrients required in trace amounts that must largely be obtained from the diet, making their inclusion in nutraceuticals important for health maintenance. Alongwith Minerals are also essential inorganic nutrients including macro and micro-minerals are involved in vital functions, including growth, reproduction, energy metabolism, immune support, and bone formation.

Fatty acids: Many metabolites of PUFAs – particularly essential fatty acids and eicosanoids derived from eicosapentaenoic acid (EPA) or arachidonic acid – contribute to the health-promoting properties of these lipids like pathophysiology and modulation of type 2 diabetes, non-alcoholic fatty liver disease, cardiovascular diseases, neurodegeneration, and cancer through several biochemical pathways, including antioxidant and anti-inflammatory mechanisms (ªimºek & Uçar, 2025).

3.0 Contribution of Nutraceuticals to Therapeutic Purposes

Nutraceuticals play a significant role in therapeutic application like allergy, resulting from hypersensitivity, is a very common problem that is often poorly recognized or difficult to diagnose, making clinical assessment challenging. Quercetin, a flavonoid and plant-derived bioactive compound, is frequently used in nutraceuticals to manage allergic conditions. Other plant-derived oils and extracts are also primarily utilised in nutraceutical formulations for allergy management (Kumar Jha et al., 2021). In Osteoarthritis (associated with joint pain)

Chondroitin sulphate (CS) and glucosamine (GLN) compounds have both pharmacological and nutritional properties which commonly used commonly used nutraceuticals for symptom management. Some nutraceuticals have contained lipoic acid as an antioxidant used to treat diabetic neuropathy. Diabetics can also benefit from ethyl esters of Docosahexaenoic acid (DHA) and n-3 fatty acid. Psyllium-based dietary fiber helps diabetics maintain their blood sugar levels and lower their cholesterol. In addition, herbal stimulants such as caffeine, green tea and ephedrine may support weight reduction. Furthermore,5-hydroxytryptophan suppresses hunger, and supplements contain chitosan, vitamin c which significantly reduces body weight. Also, they used to manage cardiovascular disease (CVD) include dietary fibre, omega-3 fatty acids, antioxidants, vitamins, and minerals. Polyphenols found in grapes aid in the prevention and management of arterial diseases. Flavonoids, which inhibit angiotensin-converting enzymes (ACE) and strengthen the small capillaries that deliver oxygen and nutrients to tissues, are present in vegetables, red wine, cherries, grapes, and apples (Swaroopa & Srinath, 2017).

Other disease conditions controlled by active nutraceutical ingredients are summarised in Table 1.

4.0. Safety Concerns and Risk Factors

4.1. Variation in raw materials and quality issues:

One of the foremost challenges in phytochemical profiling is the inherent variability in plant metabolites composition influenced by environmental factors such as climate, soil quality, season, and geography. For instance, studies on *curcuma longa* (turmeric) shows wide regional variation in curcumin content, complicating the standardisation of plant extracts, required for consistent therapeutic efficacy and safety in pharmaceutical applications (Pahare et al.,2023).

4.2. Adulteration and pesticides

Nutraceuticals are typically over-the-counter supplements making their safety is critically important. Risk includes contamination, intentional or unintentional adulteration (presence of an undeclared substance, inconsistent composition profile, fertilisers, heavy metals or microorganisms) and may be arise during product development or storage leading to infection or serious conditions such as liver damage, gastritis, and potentially fatal complications.

4.3. Challenge with Poly herbal and multi-ingredient formulations

Poly-herbal formulations are complex because of their numerous bio active compounds and interactions between herbs that can affect safety and efficacy. Standarisation and quality control are essential for ensuring the consistency of composition and safety yet developing the reliable extraction and graduation method remain challenging. Maintaining the stability of this formulation during processing and storage is also critical. Because may have unpredictable effects comprehensive toxicity assessments are required to ensure the safety of polyherbal formulations. Additionally, comprehensive toxicity evaluation and optimization of bioavailability including solubility and absorption are essential to maximise therapeutic effect

Table-1: List of nutraceuticals for management of different diseases

Sl. No.	*Disease Condition*	*Active Ingredients of Nutraceuticals*
1	Allergy	Quercetin
2	Obesity	Psyllium fibre, green tea, capsaicin
3	Alzheimer's	Lycopene, curcumin, lutein
5	Cancer	Daidzein, β-carotene, biochanin, lycopene
6	Inflammation	Glucosamine, chondroitin, vitamin C
7	Cardiovascular disease	Octacosanol, n-3 PUFAs, tannins, anthocyanins
8	Immunity problems	*Astragalus*, garlic, *Echinacea angustifolia*
9	Diabetes	Omega-3 fatty acids, psyllium, isoflavones
10	Miscellaneous	*Moringa oleifera* Lam., β-carotene, kaempferol, saponins, terpenes, curcumin, chitosan

Adapted from Jha et al., (2021)

4.4. Toxicity of nutraceuticals

Many consumers perceive nutraceuticals especially medicinal plants are inherently safe and due to their long period of traditional use. However, conventional therapeutic agents, nutraceuticals may also produce adverse effects and require cautious. As herbal remedies are increasingly regarded as drugs, proper formulation and safety evaluation are essential. Given the widespread consumption of diverse nutraceuticals and plant species, rigorous safety assessment and rational use are critically important

5.0 Safety Evaluation and Standardisation

5.1 Clinical safety

The therapeutic potential of nutraceuticals in chronic diseases is supported by growing clinical studies indicating have benefits of Omega-3 fatty acid can reduce cardiovascular risk in high risk, berberine may be as effective as metformin glycemic index and curcumin may alleviate symptoms of inflammatory bowel diseases and rheumatoid arthritis. However, variability in patient populations, formulation types, and resource designs raise questions about the generalizability of these finding. Moreover, many trials show weak or inconsistent effects in rigorous settings and furthermore, many trials rely on surrogate endpoints rather than the hard clinical outcomes limiting their translation value

5.2 Standardization

A major obstacle in evaluating nutraceuticals and functional foods is a lack of standardization in manufacturing processes variability in raw materials, processing methods, and formulation can leads to inconsistent in product potency, quality efficacy, and safety. Ensuring the consistent quality potency and safety requires validated analytical methods and robust quality control systems.

6.0 Future Perspectives

Nutraceuticals represent an expanding sector that integrates nutrition and medical care offering as a dietary supplement to help prevent chronic diseases such as cardiovascular disorders, cancer and other. Although nutrition is increasingly recognized as a key determinant of Health, healthcare system remains largely drug-centered. Innovations such as genetically modified crops and nanotechnology-based delivery systems are expected to enhance the nutraceuticals efficacy, targeting and market growth fostering better integration of nutrition and medical treatment in future.

7.0 Conclusions

Nutraceuticals are an expanding Sector that bridges nutrition and therapeutics, supported by traditional knowledge and modern scientific evidence. They play an important role in managing diseases such as diabetes, cardiovascular disorders, and chronic inflammatory conditions. However, challenges including inconsistent formulations, raw material variability, and inadequate standardization affect their safety, efficacy, and quality The future progress in nutraceutical industry will rely on advances in nutrition science, digital health technologies and stringent safety and ethical production practices to ensure consumer trust and establish nutraceuticals as a reliable adjective in preventive and therapeutic healthcare.

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Implementing ISO 22000 and FSSC 22000 in Dairy Plants to Mitigate Cross-Contamination of Antimicrobial Resistance

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Abstract

Antimicrobial resistance (AMR) is a global One-Health issue that impacts food production systems, particularly in the dairy sector, and transcends clinical environments. The management of raw milk, communal equipment, biofilms, human vectors, and environmental reservoirs presents distinct cross-contamination challenges in dairy processing operations. The Global Food Safety Initiative's (GFSI) sanctioned FSSC 22000 scheme and ISO 22000:2018 exemplify Food Safety Management Systems (FSMS) that provide organized frameworks facilitating hazard analysis (HA), validation/verification, prerequisite programs (PRPs), and ongoing enhancement. Provided that AMR-specific surveillance, biofilm-validated sanitation, supplier regulation, and sanitizer management are integrated into the FSMS. This technical opinion asserts that proactive certification under ISO 22000 and FSSC 22000 markedly enhances dairy facilities' capacity to avoid, identify, and control cross-contamination by antimicrobial-resistant bacteria.

1.0 Introduction

Given that human, animal, and environmental reservoirs continuously interact and might facilitate the dissemination of resistant bacteria and resistance genes, antimicrobial resistance (AMR) increasingly demands a One-Health approach. Resistance in dairy systems can originate on farms through the administration of antibiotics for therapeutic or prophylactic reasons (such as mastitis treatment), persist in raw milk, continue in processing environments, and subsequently disseminate to handlers or final products (WHO, 2016). Consequently, contaminated raw milk, biofilms on equipment surfaces, inadequate cleaning and sanitization, cross-contamination between personnel and equipment, and environmental niches such as drains and condensate provide the dairy processing environment both a potential reservoir and a catalyst for antimicrobial-resistant organisms. Due to the systemic nature of these mechanisms, the mitigation of AMR at the plant level necessitates the implementation of formalized, audited management systems that integrate validated prerequisite programs (PRP), risk-based hazard analysis, and regular verification, alongside ad hoc interventions (Ban-Cucerzan et al., 2025).

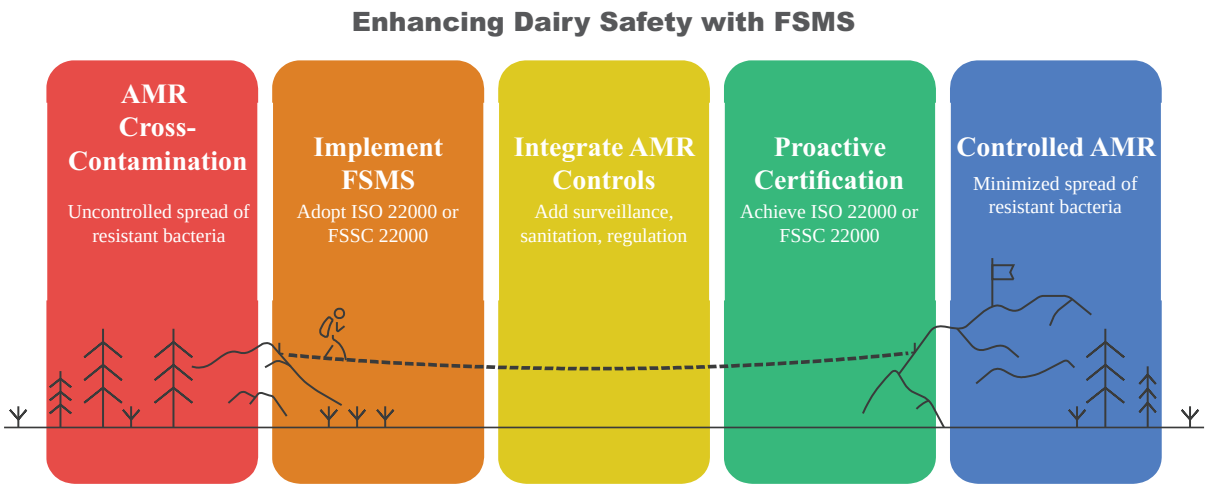

Fig 1: FSMS Process Flow Chart

According to ISO 22000:2018, a food safety management system must traditionally include HACCP principles, prerequisite programs (PRPs), and components of management systems such as leadership, planning, support, operation, performance evaluation, and improvement. The standard emphasizes risk-based management and is comprehensive, allowing for application throughout the food chain. FSSC 22000 is a scheme that enhances ISO 22000 by including scheme-level additional requirements and guidelines, together with sector-specific PRP requirements such as ISO/TS 22002-1. The importance of FSSC 22000 Version 6 for export and retail supply chains requiring GFSI-recognized certification heightened with the inclusion of normative-PRP criteria and the attainment of GFSI recognition. Certification is crucial as it fosters documented implementation beyond mere design, regular third-party verification, supplier mandates, and continuous improvement practices that directly enhance the controls necessary to mitigate AMR bacterial cross-contamination risks (IAF & ISO, 2020).

Organized PRP (OPRP), hazard analysis validation, monitoring, and continuous improvement constitute an effective Food Safety Management System (FSMS) as illustrated in Fig 1. PRP should be revised to: (a) limit the acceptance of contaminated milk and ingredients via raw material acceptance and segregation protocols; (b) adopt validated cleaning and sanitation procedures, including CIP validation and biofilm management strategies; (c) integrate pathogen testing and their resistance profiles (when feasible) into environmental monitoring initiatives; (d) address microbial and AMR risk factors in supplier assessments and specifications; and (e) rigorously uphold personnel hygiene, zoning, and cross-flow regulations. To inform the OPRP, critical control points (CCP), and verification frequency, hazard studies must consider antimicrobial resistance (AMR) as an additional hazard characteristic, specifically the “presence of Salmonella with clinically significant resistance” alongside the “presence of Salmonella.” Ultimately, a critical verification should include molecular detection of resistance genes, culture-based testing accompanied by antimicrobial susceptibility testing (AST), and, when feasible, higher-resolution methodologies such as whole genome sequencing (WGS) for trend analysis and attribution. These system enhancements convert FSMS into a functional basis for AMR risk mitigation, rendering certification more than mere documentation (Zou & Liu, 2018).

2.0 Critical Dairy Processing Challenges and FSMS-Based Remedies

2.1 Cleaning-in-Place (CIP) and Biofilms

Mixed-species biofilms on stainless steel, gaskets, pipes, and drains protect bacteria from disinfectants and can substantially diminish Clean-in-Place (CIP) efficacy, posing a significant operational challenge in dairy facilities (Galié et al., 2018). Empirical research indicates that various pathogenic and spoilage taxa persist in processing lines despite Clean-in-Place (CIP) procedures, with dairy isolates that form biofilms – particularly Bacillus species and other resilient environmental organisms exhibiting greater resistance to

CIP and disinfectants compared to non-dairy strains (Grau-Sánchez et al., 2018; Khadka et al., 2019). This persistence not only promotes continuous product contamination but also creates microenvironments conducive to horizontal gene transfer, potentially spreading resistance genes across many taxa. PRPs must necessitate validated CIP parameters and incorporate enzymatic cleaning alternatives, challenge-based validation (biofilm removal efficacy), and combined chemical-physical approaches (Curioni et al., 2021). Ban-Cucerzan et al. (2025) assert that certification requires environmental monitoring and documented validation, facilitating the discovery and elimination of persistent biofilms.

2.2 Sanitary zoning, product flow, and facility architecture

The risk of cross-contamination is heightened by obsolete or poorly designed facilities, including shared lines, mixed raw and finished product flows, and complex plumbing that hinders effective Clean-in-Place (CIP) procedures. Hygienic design, hygienic maintenance, and preventive maintenance protocols that reduce contaminant niches are essential for ISO/FSSC PRPs. These engineering controls are mandatory rather than discretionary, as the guidelines and annexes establish realistic standards for sanitary design and environmental monitoring (FSSC Foundation, 2023).

2.3 Workflow and Human Factors

Incidents of contamination are frequently attributed to personnel movement, training, and conduct. The efficacy of human controls is enhanced by FSMS components pertaining to internal audits, delineation of roles, documentation of training, and management commitment. Corrective action techniques facilitate the closure of feedback loops, whereas certification audits expose procedural and cultural deficiencies. This involves instructing personnel on the hazards of AMR, sample management, cross-contamination prevention, and sanitizer stewardship - subjects that certification programs formalize (Zimon et al., 2020).

2.4 Supply Chain

Agricultural operations may contribute significantly to the AMR load. The supplier controls of FSSC 22000 are generally more prescriptive and enforced, while accredited systems necessitate supplier approval and stipulations. The probability of introducing high-risk items into the facility is diminished by implementing supplier audit systems, establishing traceability for antibiotic usage, and adhering to supplier microbiological and antimicrobial resistance requirements (Pires et al., 2024; FAO, 2025).

2.5 Empirical Deficiencies

Multiple scoping reviews delineate antimicrobial resistance (AMR) patterns in dairy farms across Asia and globally, highlighting surveys of E. coli, S. aureus, and other pathogens exhibiting significant resistance to tetracyclines, â-lactams, and aminoglycosides. An extensive body of literature elucidates AMR in dairy farm settings, including feces, slurry, wastewater, and the farm environment, alongside increasing evidence of AMR genes in dairy-associated ecosystems (Veloo et al., 2025). A substantial body of research on biofilms, CIP resistance, and advanced cleaning techniques in dairy processing such as enzymatic formulations and combined chemical approaches demonstrates that validated cleaning and combination treatments can significantly reduce biofilm biomass and viable counts in both pilot and industrial settings. This research (Patil et al., 2021) supports the mechanistic plausibility that improved sanitation and validated PRPs can reduce AMR reservoirs in plants.

Nevertheless, there is limited empirical research that directly compares accredited and non-accredited dairy facilities for AMR outcomes, or that investigate the occurrence of AMR in these facilities prior to and subsequent to ISO 22000 or FSSC 22000 certification. The literature on the efficacy of ISO 22000 indicates that enhanced HACCP implementation, adherence to process control, and superior hygiene metrics are typically observed in certified organizations (Banovic & Markovic, 2016). Nonetheless, these studies typically present conventional food safety indicators or compliance results instead of the incidence of antimicrobial resistance (AMR) itself (Jairath & Purohit, 2013). Consequently, a significant data deficiency exists: while certification improves systems that purportedly reduce AMR cross-contamination, multi-site, longitudinal studies measuring AMR endpoints are necessary to assess the magnitude of the impact. When formulating direct causal claims, this gap must be acknowledged (Sasikumar Nair et al., 2023).

3.0 Roadmap for Prioritization and Implementation

Dairy facilities must have a strategic plan to implement certification as a method to mitigate antimicrobial resistance (AMR). Initially, allocate cross-functional responsibilities (production, procurement, sanitation, and quality assurance) and secure commitment from senior management for resource allocation. Identify AMR-specific deficiencies, like insufficient AMR surveillance, absence of biofilm challenge tests, or inadequate supplier criteria, by performing a gap analysis in accordance with ISO 22000:2018 and the relevant PRP standard (e.g., ISO/TS 22002-1) or the FSSC 22000 V6 Scheme (Zou & Liu, 2018). Furthermore, employ risk rating to evaluate controls (drains, raw milk reception, pasteurizer seals, and CIP validation) and broaden the HACCP hazard analysis to explicitly incorporate AMR as a factor. Synchronize verification schedules to focus on higher-risk nodes and accurately delineate OPRPs and CCPs. Furthermore, enhance PRPs by instituting a risk-based environmental monitoring program that encompasses focused AMR testing (culture + AST and PCR for priority genes), regulating sanitizers (rotation, concentrations, and contact duration) to avert selection pressure, employing enzymatic or combined cleaning as required, and validating CIP protocols (including biofilm challenge assessments). Incorporate microbiological and antimicrobial resistance (AMR) stipulations into procurement contracts and arrange supplier evaluations (Guerrero-Navarro et al., 2022). Establishing data and verification protocols is also advantageous. This encompasses management evaluations associated with AMR trends, root cause analysis for AMR detection, CAPA documentation, and regular environmental and product testing for infections and resistance profiles. Utilize external accredited laboratories for AST and sequencing to guarantee source attribution whenever feasible (WHO, 2016). Fifth, integrate behavior-based observations and leadership metrics into routine audits; educate personnel on antimicrobial resistance concerns, biofilm management, sanitizer use, and sampling protocols. Finally, document all aspects: supplier assessments, sanitation verifications, monitoring results, and audit documentation. Certification audits will examine records and the effectiveness of corrective efforts (Zimon et al., 2020).

3.1 Metrics for Monitoring Effectiveness

Implementing SMART (Specific, Measurable, Achievable, Relevant, Time-bound) indicators across process, environmental, product, and trend-analysis domains is essential for evaluating the effectiveness of modifications to the Food Safety Management System (FSMS) in mitigating antimicrobial resistance (AMR) cross-contamination. Examples of process-level metrics include the proportion of precondition programs (PRPs) and operational PRPs (OPRPs) that are verified and maintained in a controlled state, clean-in-place (CIP) validation log-reduction values, and the monthly count of sanitation non-conformities. The proportion of environmental samples that yield positive results for target organisms and the proportion of isolates exhibiting specified resistance characteristics serve as examples of environmental indicators. Metrics related to the product may track both the proportion of completed lots displaying pathogen detection and the proportion of lots having resistant isolates. Finally, molecular typing or whole-genome sequencing (WGS) can facilitate source identification and long-term surveillance, whilst time-series control charts can differentiate between persistent strains and sporadic contamination events.

3.2 Limitations, Costs, and Equality Concerns

Advanced AMR surveillance and certification necessitate substantial resources. The costs associated with further environmental sampling, AST, periodic sequencing, and CIP improvements may be excessive for small and medium-sized enterprises (SMEs). Regulators and industry groups should consider subsidies, collaborative laboratory networks, or incremental compliance strategies due to the potential variability in implementation based on regional differences and enterprise size. Scientific limitations encompass intricate attribution (agricultural versus botanical origin) and detection sensitivity; occasionally, low-prevalence resistant subpopulations may be overlooked without selective enrichment. Consequently, policy formulation must emphasize capacity enhancement and achieve a balance between feasible surveillance methods and achievable PRP advancements (Veloo et al., 2025).

3.3 Research Agenda

It is being necessitated that longitudinal and comparative investigations that assess AMR endpoints pre- and post-certification, or that juxtapose accredited and non-accredited facilities matched by size and

processing profile, to progress from mechanistic plausibility to quantifiable impact. Molecular detection of resistance determinants (qPCR), antimicrobial susceptibility testing panels for priority drugs, environmental and product monitoring, and whole genome sequencing for strain tracking and source attribution are all essential components of study. Conducting interventional studies of established biofilm removal strategies, employing enzymatic cleaning-in-place and mixed chemical cycles with antimicrobial resistance outcomes, might also be advantageous. One-Health research must be prioritized by funding organizations and industry consortiums to guide certification standards and evidence-based policy.

3.4 Recommendations for Industry and Policy

Regulators and industry associations ought to assist SMEs through subsidies or access to communal laboratory services while endorsing ISO 22000 and FSSC 22000 as foundational food safety management systems. Scheme owners and auditors should consider incorporating optional AMR modules or recommendations for environmental surveillance and biofilm validation. Public health groups should advocate for laboratory networks to enable routine antimicrobial susceptibility testing and molecular diagnostics for industrial verification. Ultimately, attribution and intervention targeting would be markedly improved by a collaborative One-Health data-sharing system encompassing agriculture, horticulture, and public health (FSSC Foundation, 2023).

4.0 Conclusion

Dairy plants can manage food safety threats through structured certification under ISO 22000 and FSSC 22000. Certification can markedly reduce the probability of cross-contamination of antimicrobial-resistant organisms when Food Safety Management Systems are explicitly adapted to include antimicrobial resistance risk factors such as validated biofilm management, antimicrobial resistance-focused environmental monitoring, supplier antimicrobial resistance requirements, and sanitizer stewardship. However, there is scant empirical evidence directly linking certification to reduced AMR prevalence in industrial environments; comprehensive comparative and longitudinal studies are necessary. Simultaneously, the most effective method to mitigate the risk of AMR cross-contamination in dairy value chains is to integrate certification with targeted operational modifications, capacity enhancement, and One-Health surveillance.

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Snapshot of 2025 FSS Regulations Amendments

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ABSTRACT

This paper provides a technical overview of the regulatory advancements initiated by the Food Safety and Standards Authority of India (FSSAI) during 2025. Driven by socioeconomic shifts and the rapid expansion of the food ecosystem, these amendments represent a proactive alignment of national standards with contemporary scientific data and international benchmarks. By institutionalizing rigorous specifications across diverse categories, ranging from Refractive Index (RI) ranges in edible oils and microbiological safety in meat matrices to specific mineral density thresholds in packaged drinking water, FSSAI has strengthened the regulatory framework to mitigate emerging risks in the food supply chain. This paper details the scientific underpinnings of these amendments and their implications for enforcement, industry compliance, and public health nutrition.

Keywords*:* FSSAI, food regulation, public health nutrition, food safety, regulatory amendments

1.0 Introduction

The Indian food consumption landscape is evolving faster than ever. The consumer's preferences for a more diversified food choice from traditional, innovative foods to packaged and convenience food is driven by socio economic and cultural transformation, urbanization and lifestyle. Recognizing the significant expansion of the food ecosystem and the heightened expectations of consumers, FSSAI has implemented a series of crucial regulatory updates in 2025, as shown in Fig 1. These were developed through a rigorous process of science-based scrutiny and multi-stakeholder consultation.

2.0 Transparency in Labelling Requirement to Empower Consumers

The heterogeneous nature of the beverage market necessitated more transparency in coffee-chicory blends to facilitate informed dietary choices. Since coffee and chicory possess distinct phytochemical profiles and vary significantly in caffeine concentration, the Food Safety and Standards (Labelling and Display) First Amendment Regulations, 2025, mandated precise Front-of-Pack (FOP) proportions. For instance, the regulations specify that instant coffee-chicory mixtures must contain a minimum coffee content of 51 percent by mass on a dry basis.This amendment addresses the requirement for consumer

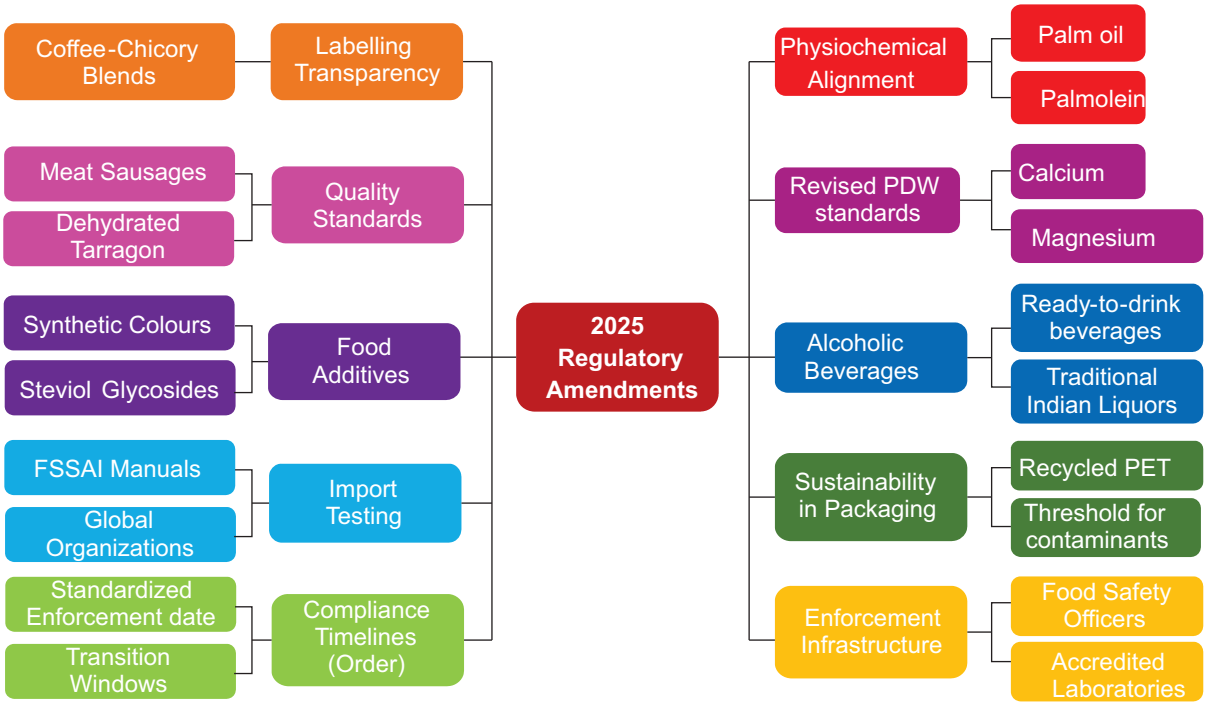

Fig 1: A Schematic Overview of 2025 Amendments in FSS Regulations

awareness regarding the percent mixture of coffee and chicory for better decision while purchasing.

3.0 Global Harmonization of Physicochemical Parameter of Edible Oils

The Refractive Index (RI) serves as a fundamental analytical parameter for verifying purity and preventing the use of cheaper substitutes. FSSAI aligned India's standards with Codex Alimentarius, the global benchmark for food safety, by amending the refractive index values for Palm Oil, Palmolein, Palm Kernel Oil, and Palm Superolein [Amendment 84, July 2025]. For Palm Oil, the RI range was revised from '1.4491-1.4552' to '1.454-1.456', while Palmolein was revised from '1.4550-1.4610' to '1.458-1.460'. Similar technical refinements were applied to Palm Kernel Oil and Palm Superolein. This alignment with Codex standards provides a robust verification mechanism for enforcement agencies to detect potential adulteration and maintain the chemical integrity of imported and domestic edible oils, thereby safeguarding the health of consumers and ensuring the authenticity of edible oils.

4.0 Quality Standards for Processed Foods

The establishment of specifications for meat sausages and dehydrated tarragon [Amendment 84, July 2025] addresses inherent vulnerabilities in processed food matrices. For meat sausages, the high surface-area-to-volume ratio of minced meat makes it highly susceptible to rapid microbial proliferation and lipid oxidation. This new regulatory framework establishes requirements for composition, thermal processing, and cold-chain storage to mitigate the risks of enteric pathogens such as *Salmonella* and *Listeria monocytogenes*. Similarly, standards for dehydrated tarragon aim to fill a void in current spice and herb regulations while improving product quality criteria and respond to its increasing utilization in the gourmet sector. Its standardization has benefited spice processors, food service enterprises, and premium exports. Since dehydrated botanicals are prone to moisture-induced microbial spoilage and the loss of bioactive volatile oils, FSSAI established standards for moisture content (not more than 10 percent) and volatile oil thresholds to ensure the retention of the phytochemical profile.

5.0 Revision in Standard of Packaged Drinking Water

The proposed amendment to the standards governing the quality of packaged drinking water [Amendment 84, July 2025], specifically targeting the Total Dissolved Solids (TDS) levels and permissible limits of vital minerals, such as calcium and magnesium, aim to not only ensure the safety and purity of bottled water but also enhance its nutritional value. By setting specific thresholds for calcium and magnesium content,

FSSAI seeks to ensure that packaged drinking water serves as a supplemental source of essential minerals that contribute to human health. Calcium levels are now standardized between 10 to 75 mg/L and Magnesium between 5 to 30 mg/L.

6.0 Standardization of Food Additives, Colours, and Sweeteners

Revised provisions for "Food Colour - Preparation and Mixtures" and the expanded application of steviol glycosides address the safety and technological requirements of food additives [Amendment 84, July 2025]. Since synthetic colours are subject to strict Acceptable Daily Intake (ADI) thresholds, standardizing mixture preparation prevents accidental over-exposure. The natural, non-caloric sweetener extracted from stevia plants is gaining popularity. Historically, its application in certain beverage subcategories was restricted to ready-to-drink products and pre-mixes for ready-to-drink products only. This amendment allows steviol glycosides in a wider array of products within the beverage category while maintaining safety standards. This provides Food Business Operators with enhanced flexibility, opportunities for sugar-reduced innovations, and simplified reformulation of products.

7.0 Regulation for Innovative and Traditional Alcoholic Beverages

The Food Safety and Standards (Alcoholic Beverages) First Amendment Regulations, 2025, standardized a new category of Ready-to-Drink (RTD) alcoholic beverages, Mead, and Nitro Craft Beer. The new category of RTDs are beverages containing 0.5% to 15% alcohol by volume (ABV), created from spirits or any other alcoholic beverage as a base, mixed with permitted additives, flavors, fruit or vegetable juices, spices, herbs, with or without added sugar or caloric sweeteners, or salt, and may include carbonation. For carbonated alcoholic ready-to-drink beverages, the regulations mandate the use of Carbon dioxide to create effervescence, requiring a minimum of one volume of Carbon dioxide. The modifications facilitate increased innovation among RTD companies, microbreweries, and craft beverage manufacturers.

This amendment refines the classification of local liquors and provides recognition for traditional Indian liquors. By incorporating an official list of Indian liquors, the amendment acknowledges a wide range of indigenous alcoholic beverages, thereby bringing these products into the mainstream of the Indian market. This recognition aligns with the national vision of "Vocal for Local," while also contributing to enhanced livelihood opportunities for Food Business Operators (FBOs) engaged in the production of such traditional beverages. The standards have been framed with the objective of supporting and standardizing traditional alcoholic beverages commonly referred to as country liquors or Indian liquors based on their geographic origin, thereby preserving their unique identity, ensuring quality, and facilitating regulated market access. In addition, the Second Amendment Regulations, 2025 revised the maximum permissible level of Esters expressed as ethyl acetate in fruit wines from "0.2" to "3.0" to align with the levels of naturally occurring esters.

8.0 Alignment of Testing Methodology and Report for Imported Food Articles

The Food Safety and Standards (Import) Regulations, 2017 mandated that notified and referral laboratories adhere to the testing methodologies prescribed by the Food Authority for the analysis of food samples, encompassing the requisite procedures and equipment. In instances where the Authority did not specify a particular method, laboratories were instructed to implement testing standards established by internationally recognized organizations such as the Codex Alimentarius Commission, the International Organization for Standardization (ISO), or guidelines provided by the Directorate General of Health Services (DGHS). To comply with the Food Safety and Standards Rules, 2011, and to clarify the procedures for testing imported articles of food, the Food Safety and Standards (Import) First Amendment Regulations, 2025 have been notified.

This amendment gives flexibility by necessitating the utilization of the FSSAI's official Manuals of Methods of Analysis, which is periodically updated. If a required method is absent from these manuals, laboratories may adopt a validated method endorsed by esteemed global organizations, including the Association of Official Agricultural Chemists (AOAC), ISO, Pearson's, Jacob, International Union of Pure and Applied Chemistry (IUPAC), Food Chemicals Codex, BIS, Codex Alimentarius, Woodmen, Winton–Winton, Joslyn, or any other internationally recognized regulatory agencies. This amendment harmonizes the import testing framework with the Food Safety and Standards Rules, 2011, assuring consistency in

testing protocols for imported samples, while allowing laboratories to implement contemporary, scientifically established methodologies as needed.

9.0 Sustainability in Packaging: rPET Guidelines

Taking into account the environmental impact of food packaging and sustainability, FSSAI permitted the use of recycled Polyethylene Terephthalate (rPET) for food contact materials [Amendment 3, March 2025]. To address the risk of chemical migration from recycled plastic, the Authority notified the Guidelines for acceptance of recycled Polyethylene terephthalate (PET) as Food Contact Material (FCM-rPET) to serve as a reference for FBOs and ensure compliance with the national standards or regulations as applicable to such materials. These guidelines ensure that contaminants are reduced below the threshold levels, facilitating the circular economy without compromising the chemical safety of the packaged food or the health of the consumer.

10.0 Policy Adopted for Ease of Doing Business

The challenges faced by FBOs are primarily related to the implementation of the regulations, required operational changes, and associated costs. Additionally, the use of pre-printed packaging materials pose obstacles in ensuring compliance with these amendments. Recognizing these issues, FSSAI took a significant step to address the challenges faced by the FBOs and provide them with a predictable and efficient framework for compliance with food labelling regulations. A decision that would promote ease of doing business, FSSAI has fixed the date of enforcement of labelling amendments specified under the Food Safety and Standards (Labelling and Display) Regulations, 2020, starting from July 1st every year subject to minimum of 180 days from the date of notification for the amendments related to FSS (Labelling and Display) Regulations and also for any change in labelling specified in other FSS Regulations [Order, January 2025].

11.0 Analytical and Enforcement Infrastructure Strengthening

The efficacy of these regulations is linked to the strength of the nation's enforcement and laboratory network. Throughout 2025, FSSAI significantly expanded its operational framework through a continuous series of Gazette Notifications. This included the strategic appointment of Central Food Safety Officers (Jan, Feb, June, July, Aug 2025) and specialized Food Safety Officers for Railways (Aug, Sept 2025), Airports,and Seaports (July, Nov 2025). These appointments were complemented by two specific enforcement drives (Aug, Nov 2025) involving 266 additional Food Safety Officers authorized to monitor the safety and distribution of fortified rice kernels.

To bolster technical capacity, FSSAI notified the appointment of Food Analyst personnel under Section 45 (Jan, Sept 2025) and expanded the Equivalent Qualification criteria for Food Safety Officers in March 2025. Governance was further strengthened through the notification of the Central Advisory Committee (CAC) in October 2025. To ensure analytical precision, the Authority expanded the laboratory network to 260 National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited laboratories and 24 Referral Food Laboratories through updated notifications in June and November 2025. Furthermore, 305 Mobile Food Testing Laboratories (Food Safety on Wheels) have been deployed under the Strengthening of Food Testing Laboratories (SoFTeL) scheme to provide rapid screening and consumer awareness at the field level.

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FSSAI's Stakeholder Consultation Approach

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ABSTRACT

This paper outlines the framework and mechanisms through which stakeholders participate in the Food Safety and Standards Authority of India's (FSSAI) decision-making, policy formulation, and standard-setting processes. By transitioning toward a participatory model under the Food Safety and Standards (FSS) Act, 2006, the FSSAI has institutionalized transparency and inclusivity as primary regulatory pillars. The approach aligns with international benchmarks, including the Codex Alimentarius Commission, International Organization for Standardization (ISO) and Organisation for Economic Co-operation and Development (OECD) principles on regulatory policy. Through the integration of digital infrastructure via the National Stakeholder Consultation (NSC) Portal, the Food Safety and Standards Authority of India ensures that food safety regulations are evidence-based, socially representative, and scientifically robust, thereby strengthening institutional trust and promoting shared responsibility across the food value chain.

1.0 Introduction

Stakeholders have played an important role in shaping the Food Safety and Standards Authority of India's policies, standards, and scientific frameworks since its inception. Engagement with diverse stakeholders ensures that food safety regulation in India remains transparent, inclusive, and reflective of the needs and expectations of consumers, industry, academia, and civil society.

With the changing landscape of food systems and increasing complexity of public health challenges, the demand for greater transparency, participation, and accountability has grown significantly. The Food Safety and Standards Authority of India recognises that meaningful stakeholder engagement enhances the quality of regulatory and scientific outcomes, strengthens trust, and promotes shared responsibility for ensuring safe and wholesome food for all. The collaborative governance approach for food safety has been illustrated in Fig 1.

The Food Safety and Standards Authority of India's Stakeholder Engagement Approach outlines the framework and mechanisms through which stakeholders can participate in the Authority's decision-making, policy formulation, and standard-setting processes at national, regional, and sectoral levels, ensuring alignment with the **Organization for Economic Co-operation and Development Recommendation of the Council on Regulatory Policy and Governance**.

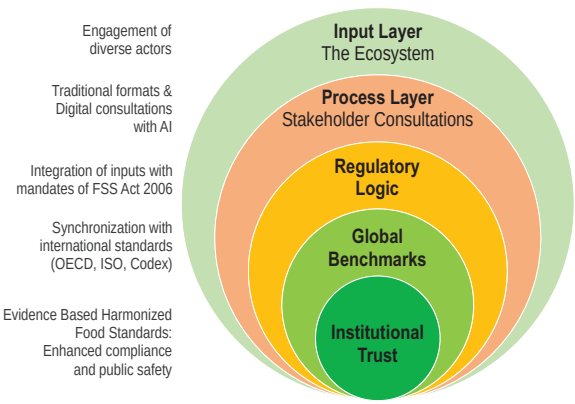

Fig 1: Collaborative Governance for Food Safety

2.0 Regulatory Provisions

The Food Safety and Standards Authority of India (FSSAI) is mandated with laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption and for matters connected therewith or incidental thereto.

The process of standard setting is driven by the principle of risk assessment and transparency. The Scientific Panels and Scientific Committee (Risk assessor) are performing risk assessment based on available scientific evidence and propose a draft standard for approval of the Food Authority (Risk manager). Also, as mandated under Section 13(2) of the Food Safety and Standards Act 2006, the Scientific Panel shall invite the relevant industry and consumer representatives in its deliberations. Once approved by the Food Authority, the draft standard is notified for inviting comments from domestic stakeholders, and World Trade Organization (WTO) member countries, for a period of 60 days.

Section 3(1)(zq) of the Food Safety and Standards Act 2006 defines the "risk management", as a process, distinct from risk assessment, of evaluating policy alternatives, **in consultation with all interested parties** considering risk assessment and other factors relevant for the protection of health of consumers and for the promotion of fair trade practices, and, if needed, selecting appropriate prevention and control options.

As defined in Clause 3.23 of the International Standard ISO 22000 – Food Safety Management Systems: Requirements for Any Organization in the Food Chain – the terms "interested party" and "stakeholder" are used synonymously, as follows:

Interested party (preferred term)
stakeholder (admitted term) *means*
person or organization that can affect, be affected by, or perceive itself to be affected by a decision or activity.

Further, as per Section 18 (2) (d) of the Food Safety and Standards Act 2006, the Food Authority shall, while framing regulations or specifying standards under this Act, ensure that there is open and transparent public consultation, directly or through representative bodies including all levels of panchayats, during the preparation, evaluation and revision of regulations.

Furthermore, as per sub-regulation 10(2) relating to Approach to work and prioritisation of the Food Safety and Standards (Transaction of Business and Procedure for the Scientific Committee and Scientific Panel) Regulations, 2016, the Scientific Committee or Scientific Panel shall afford an opportunity of scientific presentations to the representatives of concerned industry and consumer groups in one of its initial meetings and take the scientific literature submitted by them on record for consultation in forming its opinion.

New Regulatory Alignment:

- **Pre-legislative Consultation Policy, 2014:** In accordance with the 2014 policy issued by the Department of Legal Affairs, the Food Safety and Standards Authority of India proactively places draft regulations in the public domain for a minimum period of 30 days to ensure the rationale and estimated impact are shared with stakeholders.
- **Organisation for Economic Co-operation and Development (OECD) Principles:** The Authority follows the **OECD Best Practice Principles for Regulatory Policy**, incorporating stakeholder feedback early in the process to enhance regulatory quality.

3.0 Stakeholders

Stakeholders are individuals, organisations, or entities that are directly or indirectly affected by, or have

a legitimate interest in, the Authority's functions and activities. The major stakeholder groups include:

- Consumers and Consumer Organisations
- Industry Associations and Food Business Operators (Large, Medium, Small Enterprises)
- **E-commerce platforms and Food Aggregators**
- Farmers and Primary Producers (**including Farmer Producer Organizations**)
- Academia and Research Institutions
- Scientific Experts
- Government ministries and regulatory bodies
- Professional and Practitioner Associations (nutritionists, dieticians, food technologists, medical professionals)
- Civil Deliver, Non-Governmental Organizations (NGOs), Self-Help Groups (SHGs) and Advocacy Groups
- Media and Communication Partners
- **International Bodies (World Trade Organization - Sanitary and Phytosanitary Measures/Technical Barriers to Trade and Codex committees)**

4.0 Objective

- To expand stakeholder access to scientific information and decision-making processes.
- To promote meaningful dialogue with diverse actors across the food value chain.
- To collect views, data, and insights from stakeholders early in the policy and standard development process.
- To build trust, awareness, and ownership of the Food Safety and Standards Authority of India's actions and initiatives.
- To enhance collaboration for implementation, compliance, and innovation in food safety.
- To build institutional trust and promote global harmonization of Indian food standards.

Stakeholder engagement at the Food Safety and Standards Authority of India is guided by a set of core principles designed to ensure regulatory robustness and public trust. The framework emphasizes **transparency** through open access to processes, data, and the rationale behind the Authority's decisions, while **inclusivity** ensures representation from all segments of the food system, accounting for regional and gender diversity. **Accountability** is maintained through clear communication on how stakeholder inputs are weighed, supported by **evidence-based dialogue** that is strictly informed by scientific data and regulatory principles. Furthermore, the Authority fosters **mutual respect and collaboration** to achieve shared food safety goals, ensures **accessibility** through multilingual and digital platforms to engage stakeholders nationwide, and adheres to **proportionality** by aligning with the Organisation for Economic Co-operation and Development's Better Regulation agenda to ensure regulatory requirements are commensurate with identified food safety risks.

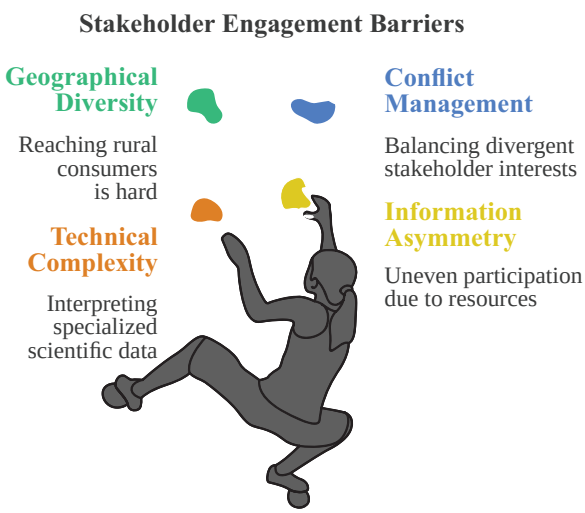

Fig. 2: Mapping the Barriers to Effective Stakeholder Engagement.

This figure illustrates the primary challenges encountered during the consultative process, categorized into four key dimensions: (i) **Technical Complexity**, involving the difficulty stakeholders face in interpreting highly specialized scientific data; (ii) **Information Asymmetry**, where disparity in resource availability between large industry players and Micro, Small and Medium Enterprises (MSMEs) leads to uneven participation; (iii) **Geographical and Linguistic Diversity**, highlighting the logistical hurdles of reaching primary producers and rural consumers in a multilingual landscape; and (iv)

Conflict Management, representing the challenge of balancing divergent interests between consumer advocacy groups and food business sectors while maintaining regulatory neutrality.

6.0 Engagement Approach

6.1 National Level Consultations: National stakeholder consultations will be organised through a structured and a pre-released annual calendar on identified food safety issues/themes. These consultations aim to engage diverse group of participants, including line ministries such as Ministry of Consumer Affairs, Ministry of Food Processing, Ministry of Agriculture and Farmers Welfare, Ministry of Commerce etc., Government departments such as Central Drugs Standard Control Organization (CDSCO), Bureau of Indian Standards (BIS), Central Insecticides Board and Registration Committee (CIB&RC), Department for Promotion of Industry and Internal Trade (DPIIT), Central Pollution Control Board (CPCB) and Agricultural and Processed Food Products Export Development Authority (APEDA), research institutions like National Institute of Nutrition (NIN), Indian Council of Agricultural Research (ICAR), Central Food Technological Research Institute (CFTRI) and National Institute of Food Technology Entrepreneurship and Management (NIFTEM), State authorities, Independent research and advocacy organizations, FSSAI-recognized testing laboratories, Representatives from consumer organizations, farmers, and food business operators alongside industry associations, which represent various sectors of the food industry contribute to policy discussions.

6.2 Regional and state level consultations:

Regional Consultative Meetings: Stakeholder engagement across different regions, in co-ordination with each Regional Office to capture local perspectives and implementation challenges.

State-level Interactions: Engagement with State Food Safety Departments, food business operators, and local consumers to ensure ground-level inclusion.

6.3 Sectoral and Thematic Consultations: In addition to geographic consultations, the Food Safety and Standards Authority of India is organising sector-specific or thematic consultations, focusing on particular domains such as Ayurveda Aahar, Nutraceuticals, Organic foods, etc.

7.0 Digital Outreach

To facilitate structured and continuous engagement, the Food Safety and Standards Authority of India has developed a dedicated digital platform - the National Stakeholder Consultation (NSC) Portal (https://nsc.fssai.gov.in/). This portal serves as a one-stop interface for registration, dialogue, and feedback from stakeholders across India, enabling evidence-based consultation and co-creation of food safety policies. The portal features user-friendly registration for stakeholder profiling, real-time notifications for upcoming consultations and calls for comments, secure submission of feedback and scientific evidence, and easy access to consultation summaries, reports, and outcomes. It allows:

- Registration and profiling of stakeholders across categories, with secure verification to ensure authenticity.
- Notifications of upcoming consultations, meetings, and calls for comments, delivered via email, Short Message Service (SMS), and in-app alerts for timely engagement.
- Submission of feedback, suggestions, and scientific evidence through intuitive forms and upload tools, supporting diverse file formats for comprehensive input.
- Access to summaries, reports, and outcomes of past consultations, including archived documents and interactive dashboards for tracking policy evolution.

This platform promotes transparency, traceability, and two-way communication, enabling both physical and virtual participation. Key enhancements via the National Stakeholder Consultation Portal include Artificial Intelligence assisted binning approach for feedback processing, collaborative workspaces for real-time co-editing of draft standards, and integration with the Food Safety and Standards Authority of India's mobile app for on-the-go access, fostering deeper involvement in evidence-based policymaking.

8.0 Implementation

The stakeholder engagement framework rolls out as follows:

- The National Stakeholder Consultation Calendar will be released annually, while Regional and Sectoral Consultations will be announced from time to time.

Table 1: Key Indicators for Monitoring Framework		
Area	*Indicators*	*Source*
Inclusivity	Number and diversity of registered stakeholders	National Stakeholder Consultation Portal
Transparency	Publication of consultation outcomes and responses	National Stakeholder Consultation Portal
Policy Impact	Policy or standards influenced by stakeholder inputs	Internal records
Collaboration	Number of sectoral partnerships and working groups formed	Consultation reports
Satisfaction	Stakeholder feedback and query resolution scores	National Stakeholder Consultation Portal

- Registration and on-boarding of stakeholders through the National Stakeholder Consultation Portal.
- Dissemination of information, theme/agenda of the consultation through the National Stakeholder Consultation portal.
- Integration of stakeholder feedback into the Food Safety and Standards Authority of India's scientific and policy processes, with periodic reporting on outcomes.
- The Stakeholder Consultation Secretariat at the Food Safety and Standards Authority of India will oversee implementation, monitoring, and evaluation of engagement activities.

9.0 Monitoring Framework

The Food Safety and Standards Authority of India will monitor and evaluate its stakeholder engagement activities to ensure that they remain effective, inclusive, and responsive to evolving needs. Key indicators are indicted in Table 1.

10.0 Expected Outcomes

The implementation of the Food Safety and Standards Authority of India's Stakeholder Engagement Approach is expected to deliver multiple benefits at the institutional, scientific, and societal levels. Improved policy and standard setting will result from broader stakeholder participation, leading to more evidence-based, practical, and harmonised food standards and regulations. Furthermore, open consultations and timely communication will enhance transparency and trust, strengthening stakeholder confidence and promoting a predictable regulatory environment. The engagement at national, regional, and sectoral levels ensures inclusive and representative decision-making, where diverse voices – especially from small enterprises, farmers, and consumers – are heard. Shared understanding and collaboration facilitate better implementation and compliance, encouraging voluntary adherence and greater ownership of food safety initiatives. Moreover, regular interactions between the Food Safety and Standards Authority of India, experts, and institutions strengthen scientific collaboration, promoting knowledge exchange and responsiveness to emerging risks. The National Stakeholder Consultation portal ensures efficient feedback and communication through continuous, traceable, and transparent interaction between the Authority and stakeholders. Finally, long-term engagement fosters sustained partnerships and capacity building, supporting technical cooperation and development across all sectors of the food system.

Consolidated Institutional Impact: The framework facilitates the development of scientifically robust food standards that are technically feasible and reflective of ground-level realities. This collaborative culture enhances voluntary compliance among Food Business Operators and fosters industry buy-in for safety initiatives, while aligning with international benchmarks such as Codex and the World Trade Organization promotes a predictable regulatory environment that reduces trade barriers. Ultimately, these outcomes position India as a global leader in collaborative food governance, striking a balance between innovation and rigorous public health protection.

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Use of Safe and Suitable Food Packaging Materials

Guidance for Food Service Establishments

(Catering/Hospitality/ Restaurants/Street Food Vendors)

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Abstract

This guidance document outlines essential protocols for food service establishments to ensure safety, integrity, sustainability of food packaging. It mandates using food-grade contact materials in compliance with regulatory standards while strictly prohibiting hazardous practices, such as wrapping food in newspapers or using non-food-grade plastics for hot items. The text provides a technical framework for transitioning to eco-friendly alternatives and detailed hygiene requirements for traditional, agro-based materials like natural leaves. Ultimately, the document is to serve as a practical roadmap for maintaining public health and regulatory compliance while promoting environmental responsibility across the catering and hospitality industry.

1.0 Introduction

Food service establishments including Catering/ hospitality/ restaurants/ street food vendors/ homebakers/ home caterer's/ Food aggregators etc., serve an essential role in providing food and dining services to

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consumers , whether through dine-in experiences or food delivery services. In the dynamic landscape of the foodservice industry, ensuring safety along with integrity of food from preparation to consumption has become a paramount concern. The packaging of food, an often-overlooked aspect, significantly impacts the safety & food quality along with overall dining experience for consumers An integral part of this process is the selection and utilization of appropriate food packaging materials. The significance of these materials goes beyond mere containment; they serve as guardians of freshness, quality, and safety, crucially impacting both consumer satisfaction and public health.

India's vibrant street food culture is a tapestry of flavours, aromas, and culinary traditions, enticing both locals and tourists alike. From delicious chaats to spicy kebabs and delectable sweets, the streets are filled with a variety of mouth-watering delicacies. Amidst this mosaic of tastes and textures, the role of safe food packaging stands as a cornerstone in preserving not just the flavours but also the health of millions who indulge in these street-side delights. Also, India's diverse culinary offerings within restaurants and hotels cater to a mosaic of tastes, preferences, and cultural nuances. The importance of safe food packaging in these establishments is diverse and essential.

Lively streets with countless street food vendors, the elegance of restaurant dining, and the luxury of hotel cuisines collectively paint a vivid picture of India's culinary prowess. Yet, this picturesque scene is overshadowed by unsustainable food packaging practices prevailing in these establishments, characterized by several pressing issues such as use of non-food grade packaging materials, single-use plastics, lack of Sustainable Alternatives, limited awareness among establishments and consumers creating challenges in regulatory compliance.

Hence, it is important to address the nuances of safe food packaging practices (as illustrated in Fig 1) offering insights and recommendations to improve the food experience while prioritizing hygiene, safety, sustainability, and compliance with regulations.

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Fig-1: **Comprehensive Food Packaging Guidance**

2.0 Background

(i) Food Safety and Standards (Packaging) Regulation, 2018:

The Food Safety and Standards (Packaging) Regulation, 2018 prescribes the general packaging requirements including the materials for packaging specific food products.

It emphasizes that all materials coming into direct contact with food, including those used for packaging, wrapping, preparation, storage, transportation, service or sale shall be of food grade quality and appropriate for the specific food product, storage conditions, and the equipment used for filling, packaging, sealing and transportation

Further, the regulation specifies a list of standards in Schedule I, II and III for Paper & board materials, Metal & Metal Alloys and Plastic Materials intended for food contact. Further, it also speci-

fies that every food business operator shall obtain the conformity certificate by NABL accredited laboratory for packaging materials that directly or potentially come into contact with food. The regulation also mentions Specific Requirements for Primary food packaging including defined migration limits for substances released from plastic materials intended for food contact. In addition, Schedule IV provides an indicative list of packaging materials suitable for use with food products across specified categories.

(ii) Objective:

The modern food service ecosystem witnesses a complex interplay between convenience-driven packaging solutions and the need for rigorous safety standards. With the increasing demand for delivery and takeaway services, the reliance on packaging has increased. This reliance, while addressing convenience, also introduces a multitude of challenges related to food safety, sustainability, and regulatory compliance. Recognizing the critical importance of proper food packaging, the need for a comprehensive guidance document becomes evident for ensuring consumer safety and health, for compliance with regulations, to upholding quality and freshness of food and to keep in mind the environmental responsibility and sustainability.

Safe food packaging is fundamental in safeguarding consumer health. Contamination risk, improper storage conditions, and inadequate packaging materials can compromise the integrity of food, leading to health hazards. This guidance document aims to outline essential protocols and adopting best practices to reduce these risks and safeguard the safety of packaged food.

Although,food safety and standards Packaging regulation, 2018 already prescribes standards for food packaging, it does not explicitly provide guidelines or list the safety aspects for packaging of foods in food service establishments like hotels/restaurants/street vendors etc. This document attempts to bring the food packaging mechanisms/ practices followed by food service establishment into the regulatory purview.

Beyond safety concerns, proper packaging contributes significantly to preserving food quality and freshness. Proper packaging materials, methods, and handling procedures can extend the shelf life of food items, ensuring that customers receive products that meet the establishment's quality standards.

Further, in an era of heightened environmental awareness, sustainable practices, including eco-friendly packaging, are increasingly valued by consumers. This document will explore sustainable packaging options that not only meet safety standards but also align with eco-conscious initiatives, showing commitment to environmental responsibility.

The committee defines the terms "Food Contact Materials" and "Food Grade Contact Material" for the benefit of the consumers and FBOs:

(i) Food Contact Material: Any substance, material (including active/ intelligent materials), product intended to come into contact with food without imparting any undesirable *technical effect* to the food, including machinery used for the manufacturing, processing, handling (including kitchenware, tableware etc), packaging, storage and transportation is called Food Contact Material (FCM).

Explanation: For purpose of this definition "technical effect" refers to, Organoleptic and Health effects.

(ii) Food Grade Contact Material: The food contact materials that are manufactured and processed using appropriate methods and ingredients (including additives) and subjected to testing to demonstrate their compliance with specific safety standards under prescribed conditions and shall not risk to human or animal health, nor cause any unacceptable change in the characteristicsor composition of food during its intended use.

Creation of this comprehensive guidance document on safe food packaging in food service establishments is essential to serve as a roadmap for ensuring consumer safety, maintaining food quality, embracing sustainability, and enhancing operational efficiency.

3.0 Guidance

3.1 Safe food packaging/serving practices for food service establishments

General list of Do's and Dont's

Do's:

1. Use only Food-Grade contact packaging materials
2. Ensure proper sealing to prevent leakage and contamination. Use secure closures and seals on packages.

3. Maintain a clean and sanitized packaging area. Use clean and hygienic packaging to prevent cross-contamination.
4. Store packaging materials in clean, dry, and designated areas, away from potential contaminants like chemicals or cleaning aids and protected from pests and rodents.
5. Train employees on proper handling and packaging procedures to maintain hygiene and prevent contamination.
6. Wherever required, prewashing/precleaning of the packaging materials at appropriate pressure or temperature of water shall be carried out to ensure removal of any residue in the contact surface.
7. Use sustainable packaging materials as much as possible. Sutures, sealants or any such agents used for shaping these materials must be of food grade quality.

Don'ts:

1. Do not pack hot foods like tea, coffee, milk, rice, curries, sambhar, gravy etc. in plastic pouches of non-food grade contact materials.
2. Food shall not be stored or wrapped using Newspaper or any such material.
3. Single use plastics such as plastic plates, trays, straw, cutlery (knives, spoons, forks), glasses, cups, and plastic wrapping or packing films used around items such as sweet boxes etc. which are banned under the Plastic Waste Management Rules as amended from time to time by Ministry of Environment, Forest and Climate Change (MoEF&CC) shall not be used as food packaging materials.
4. Single-use Packaging materials shall not be reused.
5. Do not use packaging materials with visible damage, tears, rust, chipped enamel, punctures, infested with insects or contaminated by rodents.
6. Undesirable chemicals should not be present in the packaging area of the food service establishment.
7. No hazardous chemicals shall be used directly/indirectly for packaging.
8. Food packaging material should retain its integrity and shall not break or tear off or partly dissolved in food unless the said material is a defined food as per FSSR.
9. No material containing any allergen should be used as food contact material without appropriate warning/ labelling.
10 Avoid using rusty containers, chipped enamelled containers and containers without proper coating

Further, compliance with the Food Safety and Standards (Packaging) Regulations, 2018, as amended from time to time, is mandatory.

3.2 Alternate Products to Plastic Packaging

Use of Alternate products as a substitute of plastic packaging is a dynamic subject. These materials generally offer sustainable solutions to address the growing concerns around plastic waste. As per available scientific literature, these materials help in reducing the environmental footprint but also align with circular economy principles while expanding the possibilities for safer and eco-friendly packaging.

Biodegradable plastics can be defined as "plastics, other than compostable plastics, which undergo degradation by biological processes in a specific environment such as soil, landfill, sewage sludge, freshwater, marine, without leaving any microplastics or visible or distinguishable or toxic residue, which has adverse environment impact." for packaging applications to safeguard our eco-system as far as the end of life option of packaging is concerned. It is very important if such food packaging should also feature as compostable plastics, means such plastic packages must demonstrate the ninety percent by mass degradation of carbon present in its plastic building block into Carbon Dioxide within 180 days under specified composting conditions. Example include ISO17088 (Plastics, Organic recycling specifications for compostable plastics), ASTM D6400(Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities), and IS 17899 T (Tentative India Standard for assessment of Biodegradability of Plastics in Varied Conditions) and any other standards which may be published globally from time to time. Plastics, such as PCL(Polycaprolactone), TPS (Thermoplastic Starch), PVA, PBS, PBAT, PLA, PHB and its blends and composites are considered as compostable plastics.

Food service establishments shall comply to the following requirements while use of these materials:

i. Food Contact Materials made of biodegradable plastics shall be labelled with the information of specific

conditions required for degradation and duration required for degradation.

ii. Food Contact Materials made of compostable Plastics shall be labelled as "degradable only under Industrial Composting Conditions or else specified."

iii. Labels, if any, pasted on such FCMs should be made of such alternate plastics.

iv. Food service establishments shall keep records of Total Migration testing conducted in an NABL Laboratory for such materials. The Total Migration Limit for such materials under IS:9845 (Bureau of India Standards, 2020) is restricted to 60 mg/Kg or 10mg/dm^3.

v. Overall Migration tests shall be performed to ensure that there is no colour migration from FCMs.

vi. Printing Inks used on such packaging shall conform to IS:15495 (Bureau of Indian Standards, n.d.), ensuring printed surfaces never contact food directly.

vii. The transparency of such packages shall not be less than 85%

3.3 Natural Agro/Biomass based Food Packaging/Serving Materials (Biopolymer based alternate to Single Use plastics)

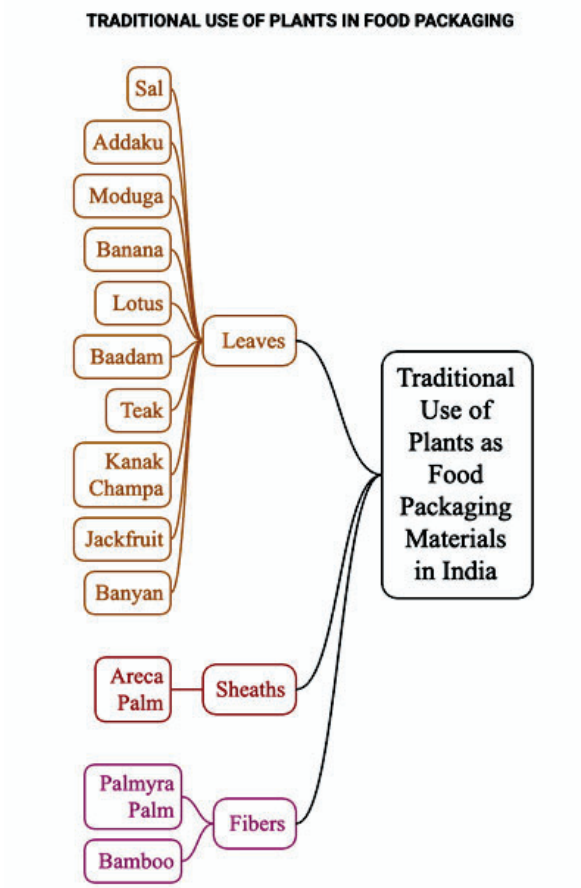

Fig. 2: **Plants derived Food Packaging Material in traditional use in India**

Natural fibers and leaves have served as food packaging and serving items for centuries. Various leaves from different plant families have traditionally functioned as single leaf plates, food wrappers, stitched leaf platters, and food packaging since ancient times (Kora, 2019). However, their application has traditionally been region-specific, purpose-driven, and tied to particular occasions and food types, limiting their universal recognition. Numerous research studies have demonstrated their positive contribution to the food experience, including enhancing aroma and freshness and even offering curative properties.

These materials, as shown in Fig 2, are recognized for their unique properties, such as the presence of phenolic compounds. For example, areca nut leaves exhibit excellent temperature tolerance, making them highly suitable for packing and serving hot foods. Similarly, the thin, foldable properties of plantain leaves make them versatile for serving, packaging, and even as contact materials in high-temperature steamed food applications. Most of these natural materials are leak-proof and non-sticky, enhancing their functionality in food service.

Traditional practices provide substantial evidence of the suitability of natural leaves for serving a variety of foods, including rice, gravies, vegetables, meat, pickles, sweets, low-pH foods like tamarind-based liquids, fermented foods, and uncooked items such as cut fruits, vegetable salads, and seasoned lentils.

The abundant supply of natural leaves presents an opportunity to promote their increased usage, which could benefit tribal and rural economies, as many of these materials are sourced from forest lands.

Table-1, drawn from scientific literature (Kora, 2019), consolidates details on plant local names, geographic distribution, cultural importance, biological traits, and leaf applications specifically for dining, serving, wrapping, and packaging serving for the reference of Food Service establishments.

Natural fibers and leaves offer an eco-friendly, functional, and culturally significant solution for food packaging and serving. Their unique properties, combined with traditional knowledge and scientific validation, make them a valuable resource in modern food service and packaging practices

Table-1: Comprehensive List of Plants used in Traditional Food Packaging in India

Sl. No.	*English/Regional Name*	*Scientific name*	*Geographical availability in India*	*Traditional use as FCM as per literature*
1.	Sal, Saluva, Dammar, and Ral	*Shorea robusta*	Forest-dependent tribal people living in the Sundargarh, Mayurbhanj, Kendujhar, Kandhmal, Debagarh, Nayagarh, Balasore, and Sambalpur districts of Odisha	The fresh leaves are used for serving small snacks such as boiled lentils and the sun dried leaves are stitched together using grass stem sticks or sewing machine to produce leaf plates and leaf bowls.
2.	Addaku, Madapaku, and Siali	*Phanera vahlii*	Forest areas of Indian states such as Odisha, Andhra Pradesh, West Bengal, Telangana, Karnataka, Tamil Nadu, Maharashtra, Bihar, Uttar Pradesh, Madhya Pradesh, Rajasthan, Punjab, Haryana, Uttarakhand, Sikkim, Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Meghalaya, Himachal Pradesh, and Jammu and Kashmir.	The shade dried leaves in 4-5 numbers are hand and machine stitched into round plates using grass stem sticks and thread, respectively.
3.	Moduga, Palasa, and Palash	*Butea monosperma*	Abundant in the states of Jharkhand, Andhra Pradesh, Telangana, West Bengal, Maharashtra, Kerala, and Punjab	Plates (vistari) and cups (dona) made of dried leaves are widely used for serving food and meals
4.	Areca palm, Areca nut palm, Beetle nut palm in English, and Vakka, Adakka, Adike, Puga, Supari, Paakku, Kamugu, and Gua in various Indian languages	*Areca catechu*	Abundantly available in the states of Kerala, Tamil Nadu, and Assam	Naturally fallen, thick sheaths are collected; water washed, soaked in hot water, and hot compressed to fabricate plates and cups. They are leak proof, water resistant, odorless; freezer, microwave, and oven safe; In terms of food safety, they are safe to use with moist food for single use and for multiple times for dry food. The leaf plates and cups are also used for holding cold and hot liquids, as they exhibit thermal resistance and shape rigidity.
5.	Kadali, Arati, Kela, Vazhai	*Musa paradisiaca*	Production of banana leaves as dining plates is commercial trade in the states of Tamil Nadu, Karnataka, Kerala and Andhra Pradesh,	Banana Leaves can be used as a plate.
6.	Lotus plant also known as Tamara, Kamal, Padma, Pankaja	*Nelumbo nucifera*	Distribution ranges from central, northern, to southern India	The leaves are used as wrappers during steam cooking and wrapping the food ingredients.
7.	Baadam	*Terminalia catappa*	Maharashtra, Karnataka, Kerala, Tamil Nadu	The fresh leaves are hand stitched into plates and used for serving food
8.	Teak also known as Teku, Thekku, Sagun, sag	*Tectona grandis*	Abundantly distributed in the states of Tamil Nadu, Karnataka, Kerala, Odisha, Madhya Pradesh, Jharkhand, Maharashtra, Rajasthan, Bihar, and Telangana	The teak leaf cups are used for serving liquid food items such as soups, cereals, raita, and dal. The leaves are also used as plates for serving food
9.	Kanak champa, Padma Pushp, Parivyadh, Muchkund	*Pterospermum acerifolium*	Distributed in the states of Himachal Pradesh, Chandigarh, Delhi, Madhya Pradesh, Odisha, West Bengal, Sikkim, Meghalaya, and Manipur	The leaves are used for serving food, making disposable plates, packaging and storing material, and fodder. They are also woven into dinner plates and bowls either by stitching with twigs or molding. Because of its large sized leaf blade, it earned the name dinner plate tree. (Chatterjee et al. 2012; Kapoor, 2018).
10.	Jackfruit, panasa, Chakka, Phanas	*Artocarpus heterophyllus*	Widely cultivated in the states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Assam, Tripura, Bihar, and Uttar Pradesh	The fresh leaves are stitched together to make round, single use, disposable. In Kerala, the leaf cones known as plavila kori are also used as spoons for drinking kanji, a rice starch soup. (Sidhu 2012; Today 2017).

Contd. on next page

Table-1: Comprehensive List of Plants used in Traditional Food Packaging in India (Contd...)

Sl. No.	English/Regional Name	Scientific name	Geographical availability in India	Traditional use as FCM as per literature
11.	Banyan tree known as Vata, Bar	*Ficus bengalensis*	Found throughout the India from sub-Himalayan region to deciduous forests of Deccan and south India	The leaves are used for making disposable plates and wrapping food
12.	Sacred fig is known as Aswatha, Bodhi, Bo, Peepal, and Raavi	*Ficus religiosa*	Found across the Indian subcontinent	The leaves are hand stitched into plates for serving food
13.	White fig is known as Juvvi, Plaksa, Pilkhan	*Ficus virens*	Telangana	The practice of eating food on juvvi leaf leaves removes pitta dosha, excessive heat generated in the body, purifies the blood, and acts as a coolant (Orabi and Orabi 2016).
14.	Elephant ear fig	*Ficus auriculata*	Distributed in the states of Manipur, Meghalaya, Assam, Karnataka, and Himachal Pradesh	They are made as plates by stitching 3-4 leaves together and used for taking food
15.	Vatta, Chamdakala, Chanda, and Boddi	*Macaranga peltata*	Karnataka, Kerala, Tamil Nadu, Maharashtra, Goa, Sikkim, and West Bengal	Because of the large size of the lamina, plates made out of these leaves are used for serving meal. These leaves are used as wraps in Kerala for the steam cooking of the sweet dishes ilayappam and ada. they provide an ideal platform for dough spreading and impart distinctive flavor to the dishes
16.	Turmeric	*Curcuma longa*	Telangana, Andhra Pradesh, Tamil Nadu, Maharashtra, and West Bengal	People use turmeric leaves as food wraps during the steam cooking
17.	Taro is commonly known as Kachu, Arvi, Chema, Seppankizhangu	*Colocasia esculenta*	Mizoram, Assam, Manipur, Himachal Pradesh, Karnataka, Maharashtra, Goa, Gujarat, Kerala, Tamil Nadu, Andhra Pradesh, Telangana, West Bengal, Bihar, Odisha, and Uttarakhand	As the leaves contain calcium oxalate crystals in the form of raphides, it is customary to boil or steam them with tamarind during cooking. The leaves are extensively used as food wraps during the steam cooking and oil frying of dishes
18.	Wild cinnamon, Therali, Vazhana, and Malabathrum	*Cinnamomum malabatrum*	Native plant of Western Ghats, tropical and subtropical Himalayas, Uttar Pradesh, East Bengal; Khasia and Jaintia hills of Assam, and Meghalaya states of India, Kerala, Karnataka, and Goa	Steam cooked in the wrapped cones made up of therali leaves
19.	Screw pine is commonly known as Pandan, Mundaka, Kedige, Mundig, Rampe, and Kaitha	*Pandanus amaryllifolius*	Karnataka, Maharashtra, Kerala states and Andaman and Nicobar Islands	The leaves are rolled, weaved like a ribbon and made into cylindrical containers, after blanching. The cylindrical leaf molds are used as food wraps during steam cooking of cylindrical idli
20.	Indian bean is known as Chikkudu, Sheem, Avara	*Lablab purpureus*	Found across the Indian subcontinent	The leaves are used for making disposable plates and wrapping food
21.	Palmyra palm is known as Thati, Toddy, Tala, Tad	*Borassus flabellifer*	states of Andhra Pradesh, Telangana, Tamil Nadu and Maharashtra	The baskets made with toddy leaves are used for packing sugarcane and toddy jaggery.
22.	Bamboo	*Bambusa vulgaris*	North- eastern States and West Bengal, Andaman & Nicobar Islands, Chhattisgarh, Madhya Pradesh and the Western Ghats	It can be heated in microwaves and ovens up to 200°C and can withstand temperatures as high as 400°F. Bamboo's thermal resistance makes it ideal for insulating hot or cold foods.

3.4 Guidelines for manufacture, handling and use of natural/processed Agro/biomass based Food Contact material

1. Using natural/processed plant parts as Food Contact material as food packing material in food service establishments like restaurants, hotels, fast food chains, street foods etc. can be a sustainable and visually appealing choice, but it's crucial to ensure they are safe for this purpose. By adhering to these guidelines, food service establishments can incorporate natural/processed plant parts as food packing material safely while promoting sustainability and adding aesthetic appeal to their presentation. Regular monitoring and adherence to best practices will help ensure food safety standards are maintained.

2. The final products, intended as food contact materials and derived from natural or processed plant parts, must adhere to specified minimum standards:

i. Final products shall be free from dirt, dust, off odour, dis-colouration, pest infestation and animal droppings.
ii. The final products shall be free from pesticide residues, toxins, contaminants, microbial pathogens or any other harmful substances.
iii. The food contact materials made from such sources are recommended for single use only.
iv. Consumer information in any form related to such products shall not mislead the consumers and shall be consistent with the actual composition of the product.
v. Wet and hot Foods served in natural/processed Agro/biomass based Food Contact material shall be consumed within 4 hours.
vi. Plant materials used as containers to store refrigerated or microwavable food shall be suitably compatible.
vii. Suitable information may be specified on the label of the packaging material, wherever required for consumer guidance:
    a. Information regarding allergen contained in the packaging material
    b. Microwave worthiness
    c. Suitable for reheating
    d. Chiller worthy
    e. Hot/Cold holding
    f. Hot/Chilled serving etc

3. The following guidelines shall be complied for manufacture of Food Contact material made from natural/processed Agro/biomass:

i. Sutures, sealants or binding fibres used, if any shall also be of food grade contact quality.
ii. The plant parts or leaves are to be thoroughly washed with clean potable water (as per IS 10500) to remove any dirt, debris, or potential contaminants. Food-safe sanitizers and detergents may be used for disinfection.
iii. Inspection for Damage or Spoilage may be conducted for any signs of damage, mold, or spoilage. Discard any leaves that appear to be unhealthy or contaminated. The leaves may be replaced regularly or immediately if they show any signs of spoilage, discoloration, degradation, deformation, leak, loss of packaging integrity, tear, insect infestation, animal and bird droppings etc.
iv. The plant parts may be stored in clean, dry, and well-ventilated areas away from potential sources of contamination.
v. The staff may be given adequate training on proper handling techniques to minimize contamination risks.
vi. Encourage the use of gloves while working with the leaves and emphasize good hygiene practices.
vii. Maintain appropriate temperature conditions to prevent bacterial growth or leaf wilting. Ensure they are stored at the ambient temperature for the specific type of leaves used.
viii. Records must be maintained detailing the origin of leaves, along with cleaning and sanitizing protocols, and all other relevant information.
ix. Good hygiene practices as specified in Schedule 4 of Food Safety and Standards (Licensing and Registration of Food Businesses) Regulation, 2011 shall be followed at every step of manufacturing, handling, storage and use of these food contact materials.

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Dairy Analogues: An Overview

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1.0 Introduction

Mother Nature has designed milk as a nutrient dense food source that nourishes and provides immunological protection to the mammalian off-spring. Because of their unique nutrient profile, most dairy foods are designated as protective foods, i.e. foods in which the concentration of essential nutrients is high in relation to the foods energy value. Production and marketing of dairy foods is highly commercialized due to their importance (nutrition and health benefits) and popularity (wide variety, vast choice, easy availability and affordability and sensory supremacy). The Food Safety and Standard Act (2006) assures the quality and safety of milk and milk products by regulating their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.

2.0 What Are Dairy Analogues?

Dairy analogues are food products that resemble traditional milk and milk products but are made using non-milk ingredients, such as plant-based proteins and fats, to replace dairy components partially or completely. Common examples include cheeses (imitation cheeses, cheese-like products, processed cheese analogues, processed cheese foods, processed cheese spreads), paneer (paneer analogues) yoghurts, and ice-cream (frozen dessert). They are designed to mimic the sensory characteristics i.e., appearance, flavour and texture, and functional properties of their dairy counterparts.

The dairy analogues originated primarily due to the following reasons:

a. To replace dairy foods for individuals with lactose intolerance and milk allergies.
b. To cater to the needs of the population demanding plant-based diet partially or wholly or those following a strict plant-based diet (Vegans).
c. To innovate and diversify the production of dairy alternatives and substitutes using a different source of ingredients, mainly plant based options, and production methods.
d. To reduce the cost of production through the substitution of selected milk components by cheaper vegetable products (some analogues, like analogue paneer, can be more cost-effective than traditional dairy versions).
e. To produce products with improved techno-functional and functional properties.

3.0 Food Safety and Standard Regulations on Dairy Analogues

As per Food Safety and Standards (Food Product Standards and Additives) Regulations 2011, Dairy Analogues in the dairy context are defined as "products in which constituents not derived from milk take the

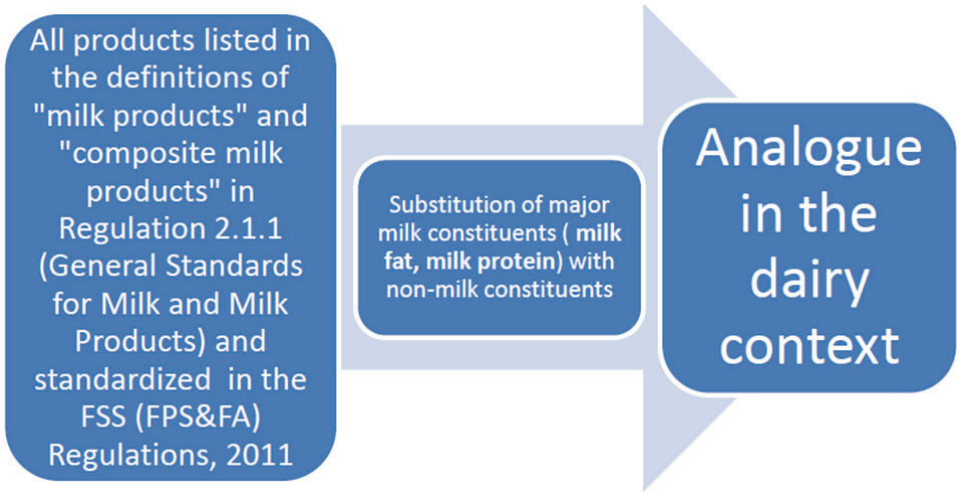

Fig 1: Dairy analogues vs Milk products

place, in part or in whole, of any milk constituent(s) and the final product resembles, organoleptically and/or functionally, milk or milk product or compositemilk product". Specifically, all milk products and composite milk products listed/standardized in the regulations, when compositionally altered with by way of substitution of their major milk constituents (milk fat and milk protein) with non-milk constituents (e.g. vegetable oil/fat, vegetable protein), the resultant (lookalike) products would be analogues. More clearly, it is depicted in the Figure-1.

Analogues are not recognized as dairy products under the regulations and are to be licensed under 'General Manufacturing-Kind of Business' as standardized food products and not under the 'proprietary food' Kind of Business (KoB). These products are mapped to the corresponding category of dairy product (e.g. analogue in the context of cheese, analogue in the context of cream etc.) in Food Safety Compliance System (FoSCoS) under General Manufacturing KoB for the purpose of licensing and applicability of corresponding additive provisions/safety standards (microbiological specifications and maximum levels of contaminants). However, two dairy analogues viz., frozen dessert and milk fat spread, have specific standards in the Food Safety and Standard Regulations.

3. 1 The following classes of milk products are not considered as dairy analogues:

■ The admixtures of certain dairy products and other ingredients not exclusively derived from milk, sale of which is prohibited as per Food Safety and Standards (Prohibition and Restriction on Sales) Regulations, 2011.

Example: Ghee which contains any added matter not exclusively derived from milk fat, and any oil or fat which does not conform to the definition of ghee; mixture and ghee or butter and any substance prepared in imitation of or as a substitute for ghee or butter.

■ Composite milk products, which are essentially milk products (dairy being an essential part of these products in terms of quantity) and also contain characterising non-dairy ingredients as permitted in the regulations (specifically not for the purpose of replacing any milk constituent), and conforming to the standards specified for individual composite milk products

Examples: *Shrikhand* with fruits; ice cream with fruits; flavoured fermented milks; drinks based on fermented milks etc.

■ Compositionally modified milk products, milk products altered in composition (eg. modification of fat content, lactose free, fortification) compared to reference product by way of addition/deletion of a milk constituent or addition of micronutrients in accordance with their regulatory standards. Examples: Full cream milk, Standardized milk, Toned-milk, Double toned milk, Skimmed milk; Medium or low-fat ice cream; Reduced lactose milk, Lactose free milk; Fortified milk etc.

■ Traditional products exclusively made from non-dairy ingredients

Examples: Coconut milk, Peanut butter, other plant-based (such as soy, nuts, rice) beverages etc.

- Products of other food categories (e.g. Cocoa products, Bakery products) containing dairy ingredients only as an essential part for characterization of the product.

Examples: Milk chocolate, Milk biscuits, Cream biscuits, Cheese cake, Butter cookies etc.

3.2 Specific Labelling Provisions for Dairy Analogues

a. If milk constituent(s) (milk fat and/or milk protein) is partly replaced by a constituent not derived from milk (eg., vegetable oil/fat and/or vegetable protein) in the product, the manner of declaration will be:

"Contains …….". (Blank to be filled with the name of the constituent and source.)

Examples: If Soy protein concentrate is used as a protein constituent, partly replacing milk protein in the product, the declaration will be "Contains Soy Protein".

If hydrogenated vegetable fat from mixed oil source is used as a fat constituent partly replacing milk fat in the product, the declaration will be "Contains Mixed Vegetable Fat".

b. If milk constituent(s) (milk fat and/or milk protein) is fully replaced/substituted by a constituent not derived from milk (eg., vegetable oil/fat and/or vegetable protein) in the product, the manner of additional declaration will be:

"Contains no …….". (Blank to be filled with name of the constituent, i.e., Milk Fat and or Milk Protein)

c. Dairy analogues for which no identity standards have been specified in the regulations shall declare on their labels the word 'Analogue' along with food category number under which the product is licensed.

Examples: For cheese, the label declaration shall be: "Analogue-1.6.5" and for cream analogue, it shall be "Analogue-1.4.4"

d. Analogues, in the dairy context, cannot use the nomenclature of milk and milk products

e. Further, as per the Draft Notification **F. No. SS-T017/1/2023-Standard-FSSAI**, 17th February, 2025 of FSSAI, all milk and milk products, including composite milk products, as per Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011, shall carry the logo as specified below (Fig. 2) on the label of the products; dairy analogues shall not use the logo.

Fig 2: Milk Logo

Even, the international regulations for dairy analogues focus on **correct labelling and preventing consumer deception**, with specific rules varying from region to region. Key requirements often include use of "non-dairy" or "analogue" in the product name, clearly listing substitute ingredients like plant-based oils, and ensuring food service establishments disclose the presence of these products on menus.

> Generic dairy terms are often restricted to their traditional meaning, preventing "analogue" products from being marketed as milk or milk products.

Analogue paneer, which has been in news in the recent months, is made by blending vegetable oils (palm oil), vegetable fats (palm stearin), starches, milk solids (SMP) and plant proteins (soy, pea) along with stabilizers, emulsifiers and artificial flavours, and curdling the blend using the common acidulants. This process creates a cheaper substitute that mimics the look and texture of paneer but has a different nutritional profile. The popularity of paneer analogues is mainly due to cost cutting, increased demand for plant-based alternatives, and claims for better nutritional, functional and sensory characteristics.

4.0 Conclusion

Being cheaper alternatives to dairy products, dairy analogues are often used to mimic the popular dairy products, especially Paneer and Cheese. This is a serious issue since such analogues are (mis)-used as the corresponding dairy products especially in the Hotel, Restaurants and Cafes/Catering (HoReCa) Sector. While provisions do exist in the Regulations, as detailed above, there is a need to introduce suitable parameters to differentiate the dairy products and their analogues. Distinct nomenclature, labelling and standards, along with simultaneous development of methods for these standards, can help distinguish dairy products from the dairy analogues. Restricting the marketing of dairy analogues, especially paneer and cheese analogues, only in the pre-packaged form of small quantities (say up to maximum 500 g per package) may also help avoid their misuse in HoReCa sector.

Beyond Tradition: Policy, Practice and Public Health Perspectives on *Ayurveda Aahara*

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ABSTRACT

Ayurveda Aahara has rapidly evolved from a largely implicit set of dietary practices within classical *Ayurveda* into a formally recognized food category that posits at the intersection of traditional knowledge, public health, innovation, and regulation. This article emphasized on ongoing policy, scientific, and market developments to outline how *Ayurveda Aahara* can function as a contemporary framework for preventive nutrition, responsible innovation, and global traditional foods dialogue.

1.0 Concept and Classical Foundations

The classical texts in *Ayurveda* accords food as a foundational role in maintaining health and preventing disease, treating *Aahara* as both a pillar of life and a primary prophylactic tool. The *Ayurveda* authoritative texts such as *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya* elaborate detailed guidance on *dosha*-specific diets, six *rasa (*tastes), food combinations, seasonal adaptation, and meal timing, often blurring the boundary between food and medicine in daily practice. In this tradition, *Ayurveda Aahara* refers to foods prepared and consumed according to such principles, aiming to harmonise body, mind, and environment through fresh, locally appropriate, mindfully prepared diets.

2.0 Contemporary Food Regulatory Context in India

India's integrated food safety law under the Food Safety and Standards Act, 2006 created a single, science-based framework for regulating manufacture, storage, distribution, sale, and import of all foods through the Food Safety and Standards Authority of India (FSSAI). Within this enforcement body, FSSAI has constituted expert committees, dynamic standards, and enforcement mechanisms to ensure safe and wholesome food, including for specialised categories such as certain food and food ingredients, and now *Ayurveda Aahara*. This unified regime in the food safety arena enables alignment of traditional food-based practices with modern risk assessment, surveillance, and consumer protection norms.

3.0 Definition and Scope of *Ayurveda Aahara*

The Food Safety and Standards (*Ayurveda Aahara*) Regulations, 2022 define *Ayurveda Aahara* as food prepared in accordance with recipes, ingredients, or processes described in authoritative *Ayurveda* texts, while explicitly excluding Ayurvedic drugs, proprietary medicines, cosmetics, narcotic or psychotropic

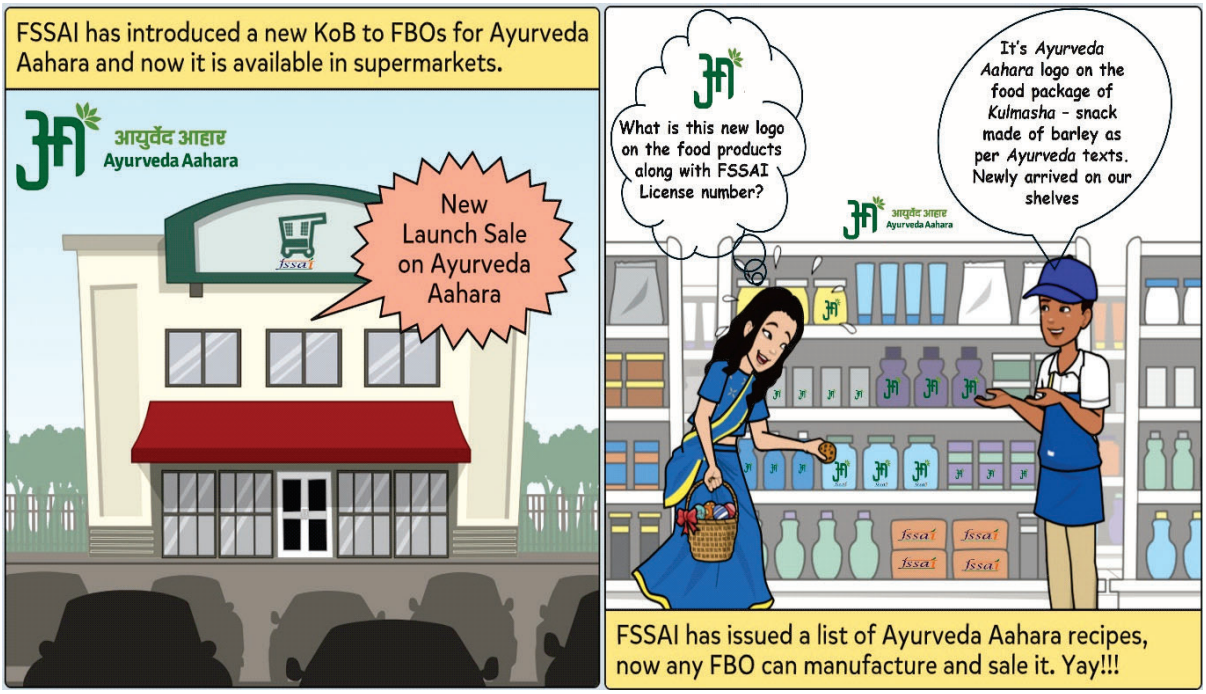

Fig-1: Illustrative representation of introduction of New KoB *"Ayurveda Aahara"*

substances. Everyday staples without added Ayurvedic ingredients, heavy metal-based preparations, Schedule E-1 herbs, (potent herbs with safety concerns if use in an unsupervised way) and foods intended for children below two years are kept outside this category to maintain clarity of scope and protect vulnerable groups. This definition creates a disciplined "middle space" between ordinary foods and medicinal products, allowing traditional recipes to enter regulated food markets without being misrepresented as cures. It's a stand-alone regulation and not combined with any other law, and India shows its leadership in the traditional foods governance regime. A simplified illustrative explanation of New Kind of Business (KoB) –Ayurveda Aahara is shown Fig-1.

4.0 Labelling, Claims, and Consumer Protection

Ayurveda Aahara food products must carry a dedicated logo, as shown in Fig 2, the term "*Ayurveda Aahara*" near the product name, and detailed information on intended purpose, target consumer group, and recommended duration of use, along with a statutory warning that they are 'only for dietary use.' The Regulations prohibit claims of prevention, treatment, or cure of diseases and restrict the use of synthetic vitamins and minerals, instead requiring transparent declaration of naturally present nutrients and limiting additives to those specifically permitted. These measures aim to build consumer trust, prevent over-medicalization of foods, and reduce the risk of misuse, especially among people with chronic illnesses or on concurrent medication.

आयुर्वेद आहार
Ayurveda Aahara

Fig 2: The logo of *Ayurveda Aahara*

5.0 Nutrition Science and Health Rationale

From a nutrition science perspective, many *Ayurveda Aahara* preparations can be understood as structured traditional foods that emphasize minimally processed, plant-forward, seasonally appropriate diets with

attention to digestion, gut health, and long-term metabolic balance. Contemporary research on traditional and Ayurvedic foods has highlighted benefits of fermented preparations, and herbs-enriched food preparations for micronutrient bioavailability, immune modulation, and chronic disease risk reduction, echoing classical emphasis on *sattvic* qualities and appropriate combinations. Thus, *Ayurveda Aahara* offers a platform for designing culturally rooted functional foods that remain firmly regulated as "food" rather than drifting into unregulated markets.

6.0 Innovation, Opportunities and Economic Potential

Innovation in *Ayurveda Aahara* spans product development, processing technologies, and business models, with particular scope in functional foods, ready-to-eat and ready-to-drink formats, and personalized nutrition offerings aligned with *dosha* and life-stage needs. Rising consumer demand for herbal, "back to roots," and immunity-supporting products, especially after the COVID-19 pandemic, has expanded market space for *Ayurveda*-based juices, confectionery, snacks, and meal components within mainstream fast-moving consumer goods. The broader Ayush sector's rapid growth and the emergence of tens of thousands of micro, small, and medium enterprises suggest that *Ayurveda Aahara* could contribute significantly to livelihood generation, rural value chains, and export-led branding of "Make in India" traditional foods. Leadership with these regulations provide great opportunity to build global brands including with an *Ayurveda Aahara* LOGO that law permits to use on all packs and in media and advertisements.

7.0 Consumer Preferences and Social Significance

Contemporary consumers increasingly seek foods that align with health, sustainability, authenticity, and personal identity, making *Ayurveda Aahara* particularly resonant due to its emphasis on naturalness, local ingredients, and personalised suitability. Innovation in traditional foods through improved convenience, packaging, safety, and shelf life can help maintain relevance while preserving sensory and cultural identity, provided that changes do not erode the core characteristics valued by communities. At a social level, *Ayurveda Aahara* encourages longer-term, habit-based dietary shifts rather than quick-fix cures, reinforcing ideas of mindful eating, balance, and shared responsibility for health within households and communities.

8.0 Technological Integration and Food Engineering

Modern food engineering offers tools to scale *Ayurveda Aahara* without compromising safety, using technologies such as controlled refrigeration, advanced packaging, pasteurization, biosensors, and digital traceability systems to maintain quality and authenticity along the supply chain. Emerging technologies – including three-dimensional food printing, smart sensors, eco-friendly packaging, and AI-enabled quality monitoring – can be adapted to develop customized *Ayurveda Aahara* products while supporting sustainability and resource efficiency. Such integration requires careful validation to ensure processing methods in respect to Ayurvedic principles on heating, fermentation, and ingredient compatibility, which can significantly affect the properties and acceptability of foods. There is immense scope to adopt innovative packaging practices from other sectors for *Ayurveda Aahara* manufacturing, subject to due diligence and validation.

9.0 Regulatory Framework and Governance Dynamics

FSSAI, as the food regulator, has embedded *Ayurveda Aahara* within the broader ecosystem of science-based standards, risk assessments, and stakeholder consultation processes, including expert committees convened with the Ministry of Ayush to evaluate traditional food products and their claims. The creation of a distinct licensing category of *Ayurveda Aahara* on the FoSCoS portal, a compendium of recognized traditional food products, and specific microbiological and hygiene norms further institutionalizes the category and offers predictability to businesses. The *Ayurveda Aahara* food products are only those that are made in pre-packaged conditions available for consumers use as per instructions for use. Being classified as food products, *Ayurveda Aahara* offers a distinct global advantage across multiple dimensions.

10.0 Globalisation and Research Agenda

The policy discourse increasingly positions *Ayurveda Aahara* as a potential contributor to global nutrition debates on sustainable, culturally grounded, health-promoting diets. Realizing this ambition, it demands robust interdisciplinary research, including clinical studies, mechanistic nutrition research, consumer behavior analysis, and social science work on equity and access, so that traditional claims are translated into contemporary evidence without eroding cultural integrity. International standard-setting, including pos-

sible engagement with Codex-style processes, could offer a platform for articulating *Ayurveda Aahara* principles in dialogue with other traditional and modern dietary systems worldwide.

11.0 Future Prospects and Policy Directions

Looking ahead, *Ayurveda Aahara* regulation policy and practice can evolve along several axes: strengthening protection of traditional knowledge, integrating *Ayurveda Aahara* into curricula for food, nutrition, and public health professionals, and fostering dedicated scientific panels and networks focused on this category. At the same time, support structures for small enterprises, including capacity-building on compliance, quality management, and documentation, will play a crucial role to ensure that formalization does not exclude informal, community-based actors. Ultimately, the promise of *Ayurveda Aahara* lies in enabling a shared "future plate" where individualized dietetics, ecological responsibility, cultural continuity, and regulatory accountability reinforce each other in everyday eating rather than remaining confined to niche wellness markets.

Further Readings

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Pesticide Residue Monitoring Data:

A Pragmatic Approach for Risk Assessment and MRL Fixation in Specialty Crops

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1.0 Introduction

Pesticides play a vital role for effective management of pests and have been instrumental in augmenting agricultural productivity by preventing extensive crop destruction, enhancing output, and consequently boosting farm income. However, their injudicious use and inherent toxicity continues to remain a pivotal challenge to the public health paradigm. Consumers have to be assured that they are not exposed to unacceptable levels of pesticide residues. Maximum Residue Limits (MRLs) are the legal standard for pesticide residues worldwide which are established by the regulatory bodies of the respective countries based on their Good Agricultural Practices (GAP) taking into account the toxicity of the pesticides.

2.0 Regulatory Framework for Pesticides In India

In India, for ensuring food, human health and environment safety, pesticide use has been put under strict regulations. Pesticide manufacture, import, export, transport, sale, distribution and use in India is regulated under the Insecticides Act 1968, and Rules 1971. Central Insecticide Board and Registration Committee (CIB&RC) facilitates registration, and the Food Safety and Standards Authority of India (FSSAI) lays down science based standards for food products. The issues related to food safety vis-a-vis pesticide residues, and Maximum Residue Limits (MRLs) etc. are dealt under the Food Safety and Standards Act, 2006 and Food Safety and Standards (contaminants, toxins and residues) Regulation, 2011. At the international level, Codex Maximum Residue Limits (CXLs) for pesticide residues in food items or in groups of food or feed that move in international trade are set by the Joint FAO/WHO Meeting on Pesticides Residues (JMPR), an expert ad hoc body administered jointly by FAO and WHO which is responsible for the scientific assessment of the pesticide toxicological and residue data.

Internationally, Joint Food and Agriculture Organization (FAO)/ World Health Organization (WHO)/ Codex Alimentarius Commission (CAC) member countries establish science-based food standards to ensure food safety, quality and fairness of international trade. India is signatory to CAC and one of the few countries in the world which has a robust system for fixing MRLs and of course the procedures for the risk assessment and fixation of MRL for the pesticide residues and other contaminants which is followed by FSSAI is in line with the international procedures followed by FAO/WHO/JMPR. The parameters that are considered to set

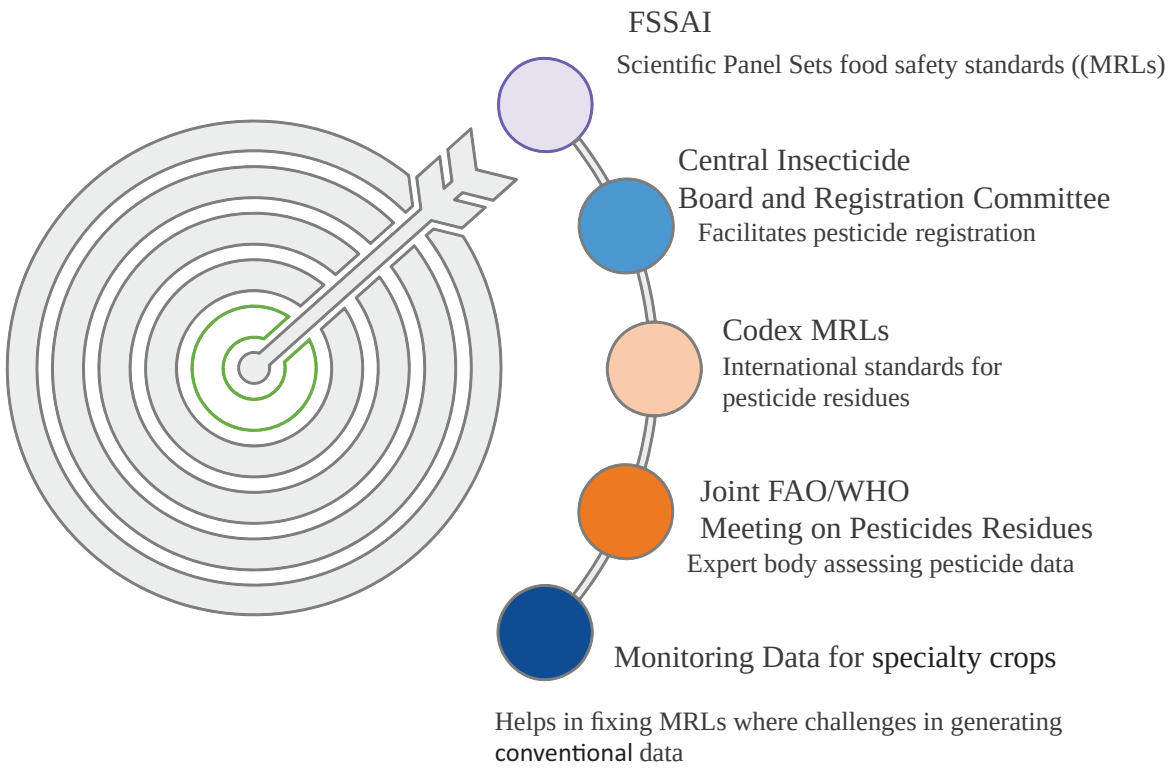

Fig 1: **Pesticide Regulation in India**

MRLs include the toxicological reference values which is the Acceptable Daily Intake (ADI), the residues that are present in food commodities, average body weight of the consumer, average consumption of the food commodity. The FSSAI MRLs are harmonized with internationally accepted Codex standards after carrying out risk assessment on Indian populations, as shown in Fig-1.

3.0 Pesticide Use in Specialty Crops: Food Safety and Trade Challenges

Globally, for setting MRLs, the residue data has to be generated in different agroclimates. One of the challenges which is encountered while setting MRLs of pesticides on specialty crops is that these crops are grown in only a limited area restricted to specialized agroclimates. Due to this, limited field residue GAP data is available which is required for MRL fixation. For the widely grown crops, various pesticides are registered for the control of pests while the minor crops such as spices do not attract commercial interest of the manufacturers to seek registration of the pesticides owing to the higher costs involved in generation of bio-efficacy, toxicology, and residue data. This results in a limited number of MRLs being fixed as the requirement for the regulatory data is not met.

After the establishment of the World Trade Order (WTO) and other General Agreement on Tariffs and Trade (GATT), & Sanitary and Phyto-sanitary (SPS) challenges, presence of pesticide residues above permissible levels is a major bottleneck. Challenges associated with minor crops are common to both developed and emerging economies. Non-availability of products for minor uses negatively impacts international/national/regional economies and lead to a surge in the cases of off-label pesticide use. Such commodities run the risk of being rejected in international trade due to off-label use of the pesticide and the absence of country MRLs. Variations in the MRLs of the same pesticide-crop combinations in the country of import and export, may also impede trade. Many countries have the practice of setting either default MRLs or fixing stringent MRLs based on their capability of detecting the pesticide residues at the lowest level.

4.0 International Data Perspective for Specialty Crops (Spices)

The challenges in the MRL fixation of specialty crops are recognized globally. Deviating from the standard data requirement of GAP studies, the JMPR accepts monitoring data for setting Maximum Residue Limits (MRLs) for spices as it is considered as a minor/specialty crop. The JMPR has developed specific guidelines

for the submission and evaluation of monitoring data for recommending MRLs for spices to ensure a consistent and scientifically sound approach. Traditionally, MRLs are established based on data from supervised field trials, which involve applying pesticides according to Good Agricultural Practices (GAP) and measuring the resulting residues. However, conducting such studies for spices is often economically unfeasible for pesticide manufacturers. Monitoring data, collected from national surveillance programs and industry bodies, provides valuable real-world information on the actual residue levels in commodities as they

Table 1: Codex MRLs fixed on spices based on Indian Monitoring Data submitted to FAO/WHO/Codex

Commodity	*Pesticide*	*Codex MRL (mg/kg)*
Cumin 	Dithiocarbamates	10
	Profenophos	5
	Acetamiprid **(extrapolated to subgroup of spices, seeds)**	2
	Carbendazim **(extrapolated to subgroup of spices, seeds)**	5
	Thiamethoxam	1
	Clothianidin	1
	Tebuconazole	0.9
Black Pepper 	Dithiocarbamates	0.1
	Acetamiprid	0.1
Cardamom 	Acetamiprid	0.1
	Dithiocarbamates	0.1
	Cypermethrin	3
	Triazophos	4
	Cyhalothrin-L	2
	Profenophos	3
Coriander seed 	Dithiocarbamates	0.1
	Phorate	0.1
	Triazophos	0.1
	Profenophos	0.1
Fennel 	Dithiocarbamates	0.1
	Phorate	0.1
	Triazophos	0.1
	Profenofos	0.1

are available in the market and move in international trade. This offers a practical way to assess typical exposure levels when formal trial data is missing. The JMPR uses this data for assessing potential consumer dietary risk, helping to ensure that the established MRLs are protective of public health.

5.0 Case Study: Pesticide Residue Monitoring Data for Risk Assessment and MRL Fixation

India is the largest producer, consumer and exporter of spices to the world. Spice commodities run the risk of being rejected in international trade on account of absence of MRLs. Variations in the MRLs of the same pesticide-crop combinations in the country of import and export, may also impede trade. To overcome these challenges, the ICAR- All India Network Project on Pesticide Residues & Contaminants (AINP-PR&C) is generating monitoring data on spices under the Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, sponsored central sector project on "Monitoring of Pesticide Residue at National Level (MPRNL). Through the India National Codex Contact Point (NCCP), FSSAI, the data is being regularly submitted to FAO/WHO/JMPR for risk assessment by JMPR and fixation of Codex MRLs (CXLs). During 2014 to 2025, Codex MRLs (CXLs) for 23 pesticide-spice combinations on five different spices (cardamom, coriander, fennel, cumin, pepper (black and white) have been fixed based on the data submitted by India (Table 1). This reflects India's scientific contribution to Codex and helps align global standards with Indian production realities, reducing the risk of export rejections in spice consignments.

6.0 Conclusion

Considering the challenges associated with conventional data generation for MRL fixation in specialty crops, the acceptance of monitoring data by JMPR provides a practically and scientifically sound alternative for establishment of Codex MRLs (CXLs). This approach plays a critical role in resolving trade disputes and ensuring a smooth flow of spices in global commerce under the WTO's SPS agreement. India's proactive engagement in generating and submitting high quality monitoring data has contributed substantially to the development of Codex standards, strengthening food safety, enhancing international trade.

Innovations in Food Safety:

Cutting-Edge Analytical Tests and Techniques for Authenticity and Contaminant Determination

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1.0 Introduction

Food testing laboratories are essential for ensuring both the safety and authenticity of food products within the increasingly complex global food supply chain. Accurate quantification of pesticide and antibiotic residues is critical for food safety and compliance with international trade regulations. Additionally, anthropogenic contaminants, including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and per- and polyfluoroalkyl substances (PFAS), as well as other hazardous substances such as dioxins and furans, pose significant risks due to their potential for bioaccumulation and carcinogenicity. Regulatory frameworks at both the global and national levels establish maximum residue limits (MRL) or tolerance limits (TL) for these compounds. Tandem mass spectrometry is recognized as the benchmark for compliance testing when analysing residues and contaminants listed in target lists across various food matrices. Despite considerable progress in recent times, these conventional residue and contaminant testing activities generate substantial waste, including organic solvents, sorbents, and plasticware. Additionally, diverse groups of naturally occurring toxins and emerging organic contaminants may be present in food and pose a significant challenge for food testing laboratories operating under a target list-based testing regime. Economically motivated adulteration (EMA) and mislabelling of food products also pose significant new challenges to food safety and authenticity, particularly where traditional testing methodologies fall short.

New analytical tests and techniques are being developed to address these emerging challenges to food safety and authenticity. Large-scope analytical methods are being developed to simultaneously quantify the maximum number of residues and contaminants possible in food. Several innovations in the sample preparation, including online automated sample preparation with the instrument, are being developed to improve the green metrics of the analytical methods. Analytical methods for food authenticity determination have also seen rapid growth, supported by innovations in instrumentation and artificial intelligence. This article presents a brief overview of these emerging techniques in food safety and authenticity determination.

2.0 Green Analytical Techniques in Residue and Contaminant Analysis

The latest trend in residue and contaminant analysis is the development of generic methods capable of monitoring a wide variety of compounds belonging to different chemical classes. This has proven challenging due to the varying chemistries and physicochemical properties. Recently, the FSSAI-NRLs of fish and fisheries products and fruits and vegetables reported a large-scope multiresidue method for the analysis of 380 microchemicals, including pesticides and antibiotics, in fish, poultry meat, and eggs (Nazar et al., 2025). The NRL on fruits and vegetables at ICAR-NRC Grapes has also recently expanded its scope of accreditation to include multiresidue testing of 779 pesticides covering almost all compounds having relevance for the country. Another study reports an analytical method using a high-resolution mass spectrometer for screening and quantification of >1100 pesticides and natural toxins in cereal products (Bessaire et al., 2024). The trend suggests an increasing use of high-resolution mass spectrometers and large-scale screening of residues and contaminants in foods to identify emerging contaminants not covered by traditional target-list-based regulatory testing. In comparison, multi-class methods for veterinary drugs are still not so widespread, although those are strongly required.

The principal methodologies that align with the principles of green analytical chemistry (GAC) predominantly involve advanced miniaturized solid-phase extraction (SPE) techniques. Key approaches include microextraction in packed syringes (MEPS), solid-phase microextraction (SPME) implemented in both direct immersion (DI) and headspace (HS) formats, stir-bar sorptive extraction (SBSE), and matrix solid-phase dispersion. In addition, several innovative liquid-phase extraction strategies have emerged as environmentally benign alternatives. These comprise single-drop microextraction, hollow fiber liquid-phase microextraction (HF-LPME), dispersive liquid-liquid microextraction (DLLME), QuEChERS, solidification of floating organic drop microextraction (SFOME), and ultrasound-assisted back extraction (UABE) (Dugheri et al., 2021; Moyo et al., 2022; Jagirani et al., 2022).

Green solvents (GSs) have frequently been integrated with these extraction techniques to enhance the efficient and sustainable recovery of target antibiotic residues GSs such as supramolecular solvents (SUPRAS), ionic liquids (ILs), and deep eutectic solvents (DES) are finding increasing application in the extraction of antibiotic residues. In particular, DES shows significant potential for antibiotic extraction, as evidenced by a growing body of literature (Shahi et al., 2022; Saei et al., 2020; Saei et al., 2022).

In recent years, there has been a significant shift towards environmentally sustainable sample preparation techniques, moving away from conventional Soxhlet extraction. Techniques such as ultrasonication-assisted extraction (UAE) and microwave-assisted extraction (MAE) have gained traction, alongside advanced methodologies like pressurized liquid extraction (PLE) and supercritical fluid extraction (SFE). These innovative approaches not only enhance extraction efficiencies but also minimize solvent consumption, thereby aligning with current sustainability objectives within analytical chemistry. MAE has been used for rapid extraction of pharmacologically active substances from animal tissue (Rodríguez-de Cos et al., 2024; Santana-Viera et al., 2023). A multiresidue analysis of tetracyclines and â-receptor agonists in chicken was developed using PLE followed by liquid chromatography-tandem mass spectrometry (LC-MS/MS) determination (Wang et al., 2020).

Liquid chromatography-mass spectrometry (LC-MS) and gas chromatography-mass spectrometry (GC-MS) continue to be the benchmark techniques for analyzing intricate matrices. Furthermore, supercritical fluid chromatography (SFC), which employs carbon dioxide as the mobile phase, emerges as a robust process within the realm of green analytical chemistry. SFC provides significant advantages, particularly in minimizing hazardous organic solvent usage by utilizing a non-toxic, eco-friendly solvent system. Furthermore, this technique enhances chromatographic separation efficiency, positioning it as a highly attractive option for contemporary analytical applications.

A comparative study assessing the separation efficacy of SFC against serial reverse-phase and hydrophilic interaction liquid chromatography (RP-HILIC) involved the analysis of 274 environmentally relevant compounds. When integrated with time-of-flight mass spectrometry (TOF-MS), both methodologies proved effective for hidden-target screening in environmental wastewater samples (Beiber et al., 2017). Additionally, the SFC-MS technique has been successfully employed to analyze multi-class pesticides across various

food matrices, demonstrating its versatility and analytical power (Ishibashi et al., 2015; Tao et al., 2018)

3.0 Advanced Analytical Techniques in Food Authenticity Determination

Food authenticity encompasses the integrity and verifiable characteristics, origin, and identity of food products, alongside their compliance with expected attributes. Unfortunately, the intricate nature of the global food supply chain has enabled the infiltration of fraudulent practices, leading to significant authenticity challenges. These issues contribute to annual losses estimated at around US $40 billion for the food industry.

In recent years, advanced analytical techniques have been increasingly employed to address concerns about food authenticity. Methods such as DNA barcoding and Next Generation Sequencing (NGS) have proven particularly effective for verifying the species identity of agricultural commodities. Additionally, Metabolomics Fingerprinting Leveraging High-Resolution Mass Spectrometry (HRMS) and Nuclear Magnetic Resonance (NMR) spectroscopy has shown considerable promise in authenticating geographical provenance and detecting complex food adulteration, particularly in honey. Furthermore, peptide biomarkers are being explored for their potential in enhancing food authenticity verification.

Ambient mass spectrometry (AMS) techniques represent recent innovations in analytical chemistry. They require little or no sample preparations and significantly reduce the time required for the sample analysis. Moreover, AMS techniques offer comparable results with the traditional mass spectrometry techniques in terms of specificity, sensitivity, and resolution (Black et al., 2016). This comprises a range of sophisticated techniques including paper spray mass spectrometry (PS-MS), direct analysis in real-time mass spectrometry (DART-MS), desorption electrospray ionization (DESI-MS), atmospheric analysis probe (ASAP-MS), rapid evaporative ionization mass spectrometry (REIMS), liquid extraction surface-mass spectrometry (LESA-MS), and high-voltage-assisted laser desorption ionization-mass spectrometry (HALDI-MS). Out of the various AMS techniques, DART-MS, REIMS, DESI-MS, and ASAP-MS are the commonly used methods for the rapid authentication of food samples (Black et al., 2016). These techniques enable the swift and direct analysis of samples in ambient conditions, simplifying the sample analysis process. AMS methods facilitate high-speed and high-throughput sample analysis, as they eliminate the need for extensive sample preparation.

4.0 Conclusion

Globalizing the food supply chain presents unique challenges to food safety and food authenticity. Target list-based monitoring of residues in food is often inadequate in globalised supply chains. Hence large-scope screening and quantitation methods are necessary. Companies often substitute expensive ingredients with cheaper alternatives or misbrand products with misleading geographic claims, undermining consumer trust and posing public health risks. To address these issues, advancements in detection technologies are crucial. Techniques such as chromatography and mass spectrometry help verify food safety and authenticity by identifying key constituents and metabolites. Recently, deep learning methods, including multilayer perceptrons (MLP) and convolutional neural networks (CNN), have enhanced the assessment of food quality and visual attributes. Other models like recurrent neural networks (RNN), autoencoders (AE), and generative adversarial networks (GAN) also show promise in this field. As technology continues to advance, deep learning can provide quicker and more accurate food identification, ultimately offering consumers safer food options and fostering progress in the food sector.

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Single Sign-On (SSO): A Unified and Seamless System for Food Import Clearance in the Country

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Food import in India is allowed through 168 Points of Entry (POEs) where FSSAI has notified Authorised Officers for food import clearance and subsequently the DGFT under the Foreign Trade (Development and Regulation) Act, 1992 notify the same POEs for import of Food items. As per the provisions of Section 25 read with Section 47(5) of the FSS Act, 2006, and Regulation 13(1) of the FSS (Import) Regulations, 2017, FSSAI has notified Authorised Officers at 168 POEs. Out of these, FSSAI officials manage 81 POEs directly (only for FSSAI related works). These 81 POEs are integrated with the Food Import Clearance System (FICS) and Indian Customs Electronic Commerce/Electronic Data Interchange (EC/EDI) Gateway (ICEGATE) under SWIFT (Single Window Interface for Facilitating Trade). About 80 to 85% of food import comes through these 81 POEs where FSSAI own officials have been notified as Authorised Officers.

For remaining 87 POEs, manned by Customs officials, FSSAI has notified them as Authorised Officers under section 25 read with Section 47(5) of the FSS Act, 2006, and Regulation 13(1) of the FSS (Import) Regulations, 2017. Thus, at these 87 POEs, Customs officials are working in the capacity of Customs officers and FSSAI officers. These POEs are mainly Land Customs Stations (LCSs), Inland Container Depots (ICDs) located in remote areas and were not integrated with FSSAI's FICS and CBIC's ICEGATE.

To ensure a unified and seamless system for food import clearance, the Food Safety and Standards Authority of India (FSSAI), in collaboration with the Central Board of Indirect Taxes and Customs (CBIC), has introduced a Single Sign-On (SSO) mechanism. The SSO functionality enables Customs Authorised Officers to access the FSSAI's Food Import Clearance System (FICS) through the ICEGATE login using a unique SSO ID allotted to individual Customs Officers by CBIC. This SSO initiative enhances transparency in food imports, ensures a level playing field through effective regulatory oversight, and significantly improves the ease of doing business in the country. This system enables the implementation of FSSAI's Risk Management System (RMS) in all these POEs.

The Single Sign-On (SSO) functionality for Customs Officers has been successfully rolled out in June, 2025. By the end of January 2026, Single Sign-On facility has been successfully implemented at the majority of POES across the country. It has been planned to achieve 100% SSO implementation at all the 87 POEs, manned by the Customs officials. Along with SSO implementation, as part of capacity building, Customs Officers notified as Authorised Officers by FSSAI for above mentioned POEs have been provided training both offline and online on the FSSAI's key regulatory requirements specified under the Food Safety and Standards Act, 2006 and FSS (Import) Regulations, 2017 made thereunder, with respect to the clearance of imported food consignments.

The implementation of SSO is a landmark step by FSSAI in regulating Food import in the Country and this will strengthen the food safety framework of imported food along with the ease of doing business.

Shaping Food Policies through 'Jan Bhagidari'

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1.0 Introduction & Portal Launch

In consonance with the vision of the Hon'ble Prime Minister and the directives of the Union Minister of Health & Family Welfare to foster inclusive governance, the Food Safety and Standards Authority of India (FSSAI) has operationalized the **National Stakeholder Consultation Portal**. This mechanism is instituted to ensure that food safety regulations and standards are formulated through a transparent, evidence-based, and participatory process. Guided by the ethos of 'Jan Bhagidari' (public participation), the initiative marks a transition towards a consultative regulatory framework, ensuring that policy interventions are developed with substantive inputs from scientific experts, industry representatives, and grassroots stakeholders.

2.0 Strengthening Food Safety: Monitoring of Pesticide Residues

Theme: *Challenges, actions, and future roadmap for effective monitoring of pesticide residues in food commodities (February 2025, New Delhi)*

The inaugural consultation addressed the integrity of the food supply chain, with representation from the Ministries of Health & Family Welfare, Agriculture & Farmers' Welfare, and Food Processing Industries. Deliberations focused on the harmonization of Maximum Residue Limits (MRLs) with international standards to facilitate trade while upholding domestic safety protocols. The dialogue focused on the management of off-label pesticide usage and the need to upgrade laboratory infrastructure for accreditation by the National Accreditation Board for Testing and Calibration Laboratories (NABL). Emphasis was laid on grassroots interventions, specifically capacity building for farmers regarding Good Agricultural Practices (GAP) and Integrated Pest Management (IPM), alongside the implementation of risk-based surveillance for high-risk commodities.

Key Outcomes:

- Consensus on fast-tracking crop grouping approach and adoption of need-based standards such as Extraneous Maximum Residue Limits (eMRLs) and processing factors.
- Commitment to coordinated enforcement mechanisms involving regulators, research bodies, and state authorities.
- Strategic focus on aligning standards for export-oriented commodities, such as spices and tea, to minimize technical barriers to trade.

3.0 Driving Sustainability: Packaging for Food Businesses

Theme: *Emerging global trends and regulatory framework for sustainable food packaging (April 2025, Mumbai)*

The second consultation examined the integration of circular economy principles within the food sector.

Discussions reviewed global regulatory trends and safety assessments related to chemical migration in Food Contact Materials (FCMs). A significant development was the notification permitting the use of Recycled Polyethylene Terephthalate (rPET) in food packaging, accompanied by the release of operational guidelines and the Food Contact Material – Recycled Polyethylene Terephthalate (FCM–rPET) logo. Stakeholders further deliberated on the viability of biodegradable materials, the establishment of Life Cycle Assessment (LCA) standards for bio-based packaging, and the integration of Extended Producer Responsibility (EPR) compliance with food safety regulations.

Key Outcomes:

- Roadmap for Adopting Circular Economy Practices in Food Packaging Operations.
- Clarification of compliance frameworks for food businesses, with specific provisions for **Micro, Small, and Medium Enterprises (MSMEs)**.
- Strengthened collaboration between industry and scientific bodies to drive innovation.
- Phased strategy for the reduction of virgin plastic usage in secondary and tertiary packaging.

Voices from the Consultations

"Food safety is not just a regulatory responsibility; it is fundamental to public health, economic stability and consumer trust."

"Sustainable packaging and truthful labeling are essential pillars of a resilient and future-ready food system."

Shri Prataprao Jadhav, Hon'ble Minister of State, MOH&FW addressed the stakeholders at Vigyan Bhawan

Smt. Punya Salila Srivastava, Secretary, MoHFW, extended regards to various stakeholders.

Stakeholder engagement session at Vigyan Bhawan

Plenary sessions during Stakeholder consultation at Vigyan Bhawan

Shri G. Kamala Vardhana Rao, former CEO, FSSAI addressed the stakeholders at Vigyan Bhawan

Open Consultation Session with Shri Prataprao Ganpatrao Jadhav, Hon'ble Minister of State, MOH&FW, at Mumbai

Shri Prataprao Jadhav, Hon'ble Minister of State, MOH&FW, launched the new rPET logo and FSSAI guidelines for the use of rPET in food packaging.

Dr. Alka Rao, Advisor, FSSAI addressed the gathering at the National Stakeholder Consultation on Sustainable Packaging

4.0 Empowering Consumers: Food Labelling, Advertisement and Claims

Theme: *Comprehensive analysis of the regulatory framework on food labelling, advertisement, and claims (August 2025, New Delhi)*

The third consultation assessed the effectiveness of existing labelling regulations related to digital commerce. The proceedings addressed concerns regarding misleading advertisements and unsubstantiated health claims, particularly on e-commerce platforms and social media. There was a consensus on the necessity of aligning domestic regulations with the Codex Alimentarius Commission (Codex) and World Health Organization (WHO) recommendations to ensure ethical communication. Participants also examined the role of multiple regulatory agencies in monitoring claims, underscoring the need for inter-agency coordination to prevent enforcement gaps.

Key Outcomes:

- Reaffirmation of food labelling as a primary instrument for consumer information and trust.
- To explore and evolve various simplified Front-of-Pack Labelling (FOPL) formats to facilitate informed decision-making.
- Dynamically evolve the review mechanism for regulations to address emerging market trends.

5.0 Bridging Science and Society: The NIFTEM-Thanjavur Initiative

Theme: *Fostering meaningful engagement with diverse stakeholders*

To extend the consultative process beyond the national capital, a specialized Stakeholder Consultative Meeting and Awareness Programme was convened at the National Institute of Food Technology Entrepreneurship and Management (NIFTEM), Thanjavur, on 19 and 20 December 2025. The objective was to ensure that regulations are formulated with direct empirical evidence and grassroots feedback, utilizing the platform of the International Conference on Food Science and Technology (ICFOST) 2025.

Key Features of the Dialogue:

- **Bilingual Communication:** Technical food safety standards and regulatory updates were disseminated in both **English and Tamil**. This approach ensured that complex policy nuances were comprehended by all participants, eliminating linguistic barriers.
- **Inclusive Engagement:** The bilingual format facilitated active participation, enabling grassroots stakeholders to articulate practical challenges directly to subject matter experts.

6.0 Participation Profile: Quantum, Gender, and Format

The consultation series registered a substantial quantum of participation, engaging thousands of stakeholders cumulatively across the national and regional chapters. A deliberate emphasis on **gender inclusivity** was observed, particularly through the high representation of women-led **Self-Help Groups (SHGs)** and Anganwadi workers in the grassroots outreach. The **sectoral composition** remained balanced, effectively bridging the divide between high-level policymakers, technical experts from academia, and frontline supply chain functionaries. In terms of **format**, the consultations adopted a hybrid model – combining physical deliberations at strategic venues, such as Vigyan Bhawan and the National Institute of Food Technology, Entrepreneurship, and Management (NIFTEM), with extensive digital outreach via the portal – ensuring both the depth of discussion and the breadth of access.

7.0 Stakeholder Voices: Diverse Perspectives

The consultations successfully collated inputs from a wide spectrum of actors, ensuring that the regulatory framework reflects the ground realities of the food ecosystem. Key contributions included:

- **Farmers & Grower Groups:** Emphasized practical constraints regarding pesticide pre-harvest intervals and requested accessible testing facilities at the agricultural market (mandi) level.
- **Recycling Industry Representatives:** Provided technical data on material collection logistics and processing capabilities, which informed the guidelines for the **Recycled Polyethylene Terephthalate (rPET)** framework.
- **Consumer Organisations:** Advocated for enhanced readability of food labels and stronger grievance redressal mechanisms to protect consumer rights against misleading claims.
- **Social Media Influencers & Digital Creators:** Discussed their role in mitigating misinformation and proposed voluntary codes of conduct for online health claims.
- **Scientific Community (PhD Scholars & Technologists):** Contributed rigorous data regarding risk assessment methodologies and emerging food technologies.
- **Grassroots Functionaries (Self-Help Groups [SHGs], Anganwadi Workers & Mid-Day Meal Vendors):** Shared critical feedback on the implementation of food safety standards in community feeding programs, ensuring policies are actionable at the last mile.

8.0 Way Forward

The 2025 National Stakeholder Consultations and the launch of the dedicated portal mark an intensified effort towards inclusive policymaking. The deliberations have identified the following strategic priorities:

- Strengthening the scientific basis of risk assessment and surveillance.
- Enhancing capacity building at the state and grassroots levels.
- Promoting sustainable innovation across the food value chain.
- Empowering consumers through transparency and awareness.

These initiatives represent a continuous commitment to aligning India's food safety measures with public health mandates and stakeholder requirements.

For more updates, visit: nsc.fssai.gov.in

India's 2025 Codex Overview: Science, Strategy, and Standards

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In 2025, India reinforced its position as a central contributor to the Codex Alimentarius Commission. The Food Safety and Standards Authority of India (FSSAI) led the development of standards across multiple committees, focusing on technical data and scientific evidence. The year demonstrated India's continued commitment to setting global benchmarks that protect public health while supporting fair trade practices.

India's national positions, as illustrated in Fig 1, were developed through a structured consultation process. The respective Codex Coordination Groups coordinated inputs from scientists, industry, and consumer groups to reach consensus. By using information on local dietary patterns and preferences and farming conditions, India ensured that the proposed standards were scientifically valid and practical for implementation in diverse food systems.

At the 23rd session of the Codex Committee on Fresh Fruits andVegetables (CCFFV23) in Mexico City, India led the standard for Fresh Dates to final adoption at CAC48 at Step 8, and the standard for Fresh Curry Leaves to Step 5/8. These standards set technical parameters – such as moisture limits and maturity indices – to prevent spoilage during transport. India also accepted the Co-Chair role for new work on Fresh Turmeric and Fresh Broccoli.

At the 55th session of the Codex Committee on Food Additives (CCFA55) in Seoul, India emphasized the principle of "technological necessity." The delegation argued that additives should only be used if they serve a specific function, even if safety limits (ADIs) allow for higher amounts. Submitting over 90 technical comments, India supported minimizing chemical use to the lowest level required, reducing the overall chemical load on consumers.

As a major producer of millets, India chaired the EWG for the Codex group standard for whole millet grains during the 11th session of the Codex Committee on Cereals, Pulses and Legumes (CCCPL11). This work addresses quality factors like protein and crude fibre. The developing standard defines moisture and safety parameters to differentiate high-quality grains, which is essential for the global trade of this crop.

In Bangkok, at the 18th session of the Codex Committee on Contaminants in Foods (CCCF18), the focus was on testing methods. Because toxins in spices often occur in "hotspots" (uneven distribution), India chaired the EWG on "sampling plans and numeric performance criteria for methods of analysis for total aflatoxins and ochratoxin A in spices." This work advanced to Step 8. It ensures that statistical sampling is used to obtain accurate results. India also contributed to the Code of Practice for the Reduction of Acrylamide in Foods, ensuring mitigation measures are practical for processors.

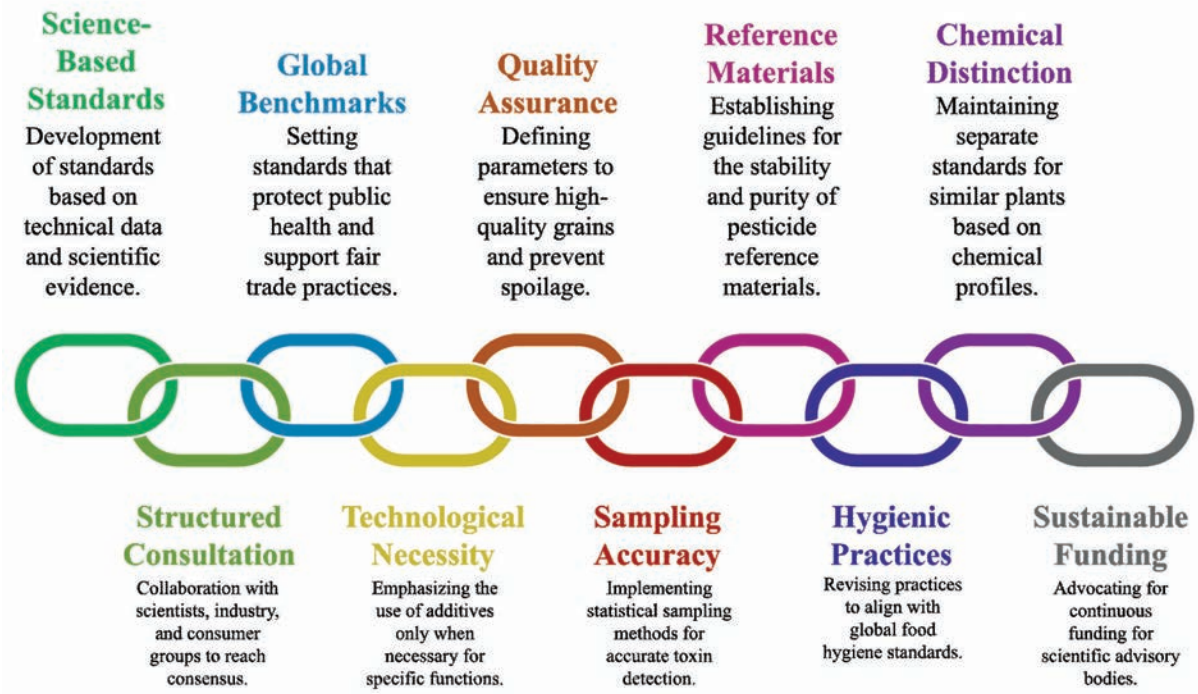

Fig 1: **India in Codex in 2025**

At the 56th session of the Codex Committee on Pesticide Residues (CCPR56) in Santiago, India chaired the development of "Guidelines for Monitoring the Stability and Purity of Reference Materials and Related Stock Solutions of Pesticides during Prolonged Storage." Advanced to Step 8, this document reduce the recurring costs associated with the procurement of certified reference materials, minimize waste and ensure confidence in the reliability of pesticide residue analysis. India also provided monitoring data to set the Codex maximum residue limit (CXL) for tebuconazole in cumin at 0.9 mg/kg, ensuring the limit reflects real-world farming practices.

At the 23rd session of the FAO/WHO Coordinating Committee for Asia (CCASIA23), the Committee established an EWG chaired by India to review the Regional Code of Hygienic Practice for Street-Vended Foods in Asia. The revision aligns traditional practices with the "General Principles of Food Hygiene (CX 1-1969)" and "Guidelines for Food Hygiene Control Measures in Traditional Markets for Food (CXG 103-2024)," specifically addressing time and temperature controls in open-air markets.

At the 8th session of the Codex Committee on Spices and Culinary Herbs (CCSCH8) in Guwahati, India supported progress on standards for dried coriander seeds, vanilla, and large cardamom. On technical grounds, India opposed merging cassia and cinnamon into a single standard. This distinction is based on different physico-chemical profiles of the two spices, particularly regarding coumarin content, which requires separate safety evaluations.

Representing Asia at the 89th session of the Codex Executive Committee (CCEXEC89), India called for sustainable funding for scientific advisory bodies. The delegation also suggested using AI-based tools to speed up risk assessments to prevent delays in policy making after the Codex Trust Fund phases out.

The year ended at the 48th session of the Codex Alimentarius Commission (CAC48) in Rome, where India was re-elected to the Executive Committee 'as a member elected' on a geographical basis (Asia). The Commission adopted the standards for Fresh Dates and the Guidelines on Pesticide Reference Materials. From proposing new work on cashew kernels to providing data for global safety limits, India continues to be a consistent, science-based partner in global food safety.

Ensuring Food Safety through a Culture 0f Continuous Learning

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1.0 Training of Regulatory Officials

The FSSAI recognizes the importance of training and education in building a competent regulatory staff. The FSSAI requires a well-trained and competent regulatory staff to ensure that food safety laws and regulations are effectively implemented and enforced. By providing regular training opportunities, the FSSAI ensures that its regulatory staff is well-equipped to carry out their duties effectively and efficiently, ultimately contributing to the safety of the Indian food supply.

Clauses 2.1.2 and 2.1.3 of Chapter 2, Food Safety and Standards Rules, 2011 underline the need for training for Food Safety Officers and Designated Officers. Considering this mandate, accordingly Induction, Refresher and Need based training are being provided to them.

During the Calendar Year 2025 a total of 25 Training Programmes were conducted for the Regulatory Officials (Designated Officers, Food Safety Officers) from various states and organizations, wherein 1,690 officials/officers were trained and the details of these programs are as follows:

i. During the year 2025, **Six Induction Training Programme** for Food Safety Officers (FSOs) had been conducted wherein a total of 362 FSOs were trained in these training programmes.

Regulatory Trainings Conducted in 2025

39th Induction Training Programme for Food Safety Officers of Telangana, Andhra Pradesh and Tamil Nadu conducted from 17.03.2025-04.04.2025 at MCRHRDI, Telangana

ii. **One Induction Training Programme** for Designated Officers (DOs) had also been conducted to a total of 43 Designated Officers were trained in this training programme.

iii. **Five Refresher Training Programmes** for Food Safety Officers (FSOs) had been conducted in which 239 FSOs were trained in these trainings during the period.

iv. **Additionally, one Refresher Training Programme** for Designated Officers (DOs) was conducted wherein a total of 26 DOs had been trained in this training programme.

14th Refresher Training Programme for Food Safety Officers of Uttarakhand, Himachal Pradesh, Assam and Uttar Pradesh conducted from 16.06.2025-20.06.2025 at State Council of Educational Research and Training, (SCERT) Dehradun, Uttarakhand

41st Induction Training Programme for Food Safety Officers of Andaman & Nicobar, Nagaland, Haryana and Maharashtra conducted from 18.08.2025-04.09.2025 at YASHADA, Pune, Maharashtra

42nd Induction Training Programme for Food Safety Officers of Andaman & Nicobar, Nagaland, Haryana and Maharashtra conducted from 18.08.2025-04.09.2025 at YASHADA, Pune, Maharashtra

43rd Induction Training Programme for Food Safety Officers of Maharashtra conducted from 25.08.2025-11.09.2025 at YASHADA, Pune, Maharashtra

v. Furthermore, during the period **twelve Need Based Training Programmes** had been organized through offline and online mode wherein a total of 1020 Regulatory Officials were trained in these training programmes.

2.0 Training of FSSAI Officials

Staff training Unit of Training Division aims to create & promote a robust culture of continuous learning & development of Officers/Officials at FSSAI.

To give impetus to the capacity building initiative in FSSAI, Staff Training Policy-2023 has been formulated and launched on 26.06.2023 to provide the FSSAI's employees with the requisite training and development opportunities.

From 01 January 2025 to till date, 2194 officials have undergone various training/workshops/certificate courses.

Staff Training Unit has successfully organized following trainings:

Induction training programme titled **Nurturing Individual Potential and Unleashing Networking (NIPUN)** for the newly recruited officials/officers to acquaint them with the organizational procedures and workflow.

■ 10th NIPUN was organized from 21st April- 9th May 2025 on-boarding 7 participants cutting across various cadres and grades at NTCFSS, Ghaziabad (Classroom) & On the Job Training at FSSAI's Regional Offices Kolkata and Ghaziabad.

Orientation Training Programme for Officers/Officials on deputation to FSSAI

■ For officials on deputation to FSSAI an Orientation Training Programme was organized from 29th April- 6th May 2025 covering 18 participants at NTCFSS, Ghaziabad and OJT at FSSAI's Regional Offices.

Need Based Trainings:

Need-based training sessions on various topics were conducted from January to December 2025 for Officers/Officials across HQ, Regional Offices, Branch Offices, and NFLs, covering both physical and online modes. A total of 1,288 officers attended these training sessions.

Training of Custom Officials engaged in Food Import Clearance System

281 Customs Officials designated as Authorized Officers were trained at Bhopal, Indore, Chandigarh, Vadodara, Lucknow, Jogbani and Kolkata.

Training of FSSAI Officials on Laboratory Quality Management Systems and Internal Auditor as per IS/ISO/IEC 17025:2017

Four-day Training Program on "Laboratory Quality Management Systems and Internal Auditor as per IS/ISO/IEC 17025:2017" was conducted at BIS Noida. A total of 8 Officers attended the training from July till date.

10th Induction Training Programme for direct recruits (21st April- 9th May 2025) at NTCFSS, Ghaziabad

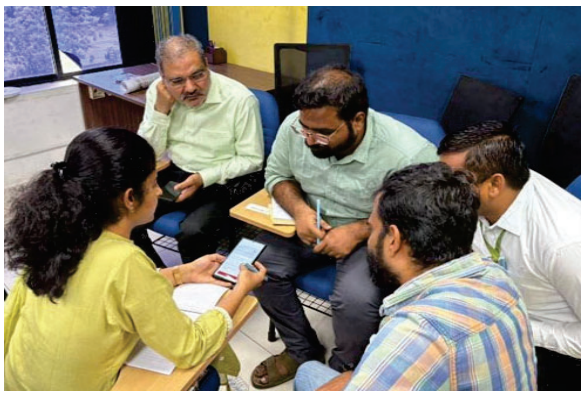
Nomination Based Training Programmes

During 2025, a total of 29 FSSAI officials attended residential programmes organized by NPC, ISTM, and the Art of Living Foundation, covering areas such as e-Procurement (GeM), RTI & Office Management, Preventive Vigilance, Good Governance, Establishment & CCS Rules, Pension/Retirement Benefits, as well as Personal Excellence. These programmes were held at NPC centres in Munnar, Gangtok, Leh, and Goa, at ISTM, New Delhi, and at the Art of Living Foundation, Bengaluru, enabling officials to enhance their technical, administrative, behavioural and governance competencies.

Orientation Training Programme for Officers/Officials on deputation to FSSAI (29th April- 6th May 2025) at NTCFSS, Ghaziabad

Need Based Training on Procurement, GeM and GFR at FSSAI HQ

Mission Karmayogi: One –Day Training Programme for Officers/Officials at FSSAI HQ



Mission Karmayogi: One-day Training Programme for Officers/Officials at Regional and Branch Offices

Mission Karmayogi

A Three-Day Masters Training Programme under Mission Karmayogi (Phase 2) was conducted from 11–13 June 2025 at FDA Bhawan for 24 Master Trainers, followed by a One-Day Employee Training Programme for 539 Officers/Officials across HQ in June 2025, Regional/Branch Offices and NFLs. These physical-mode training aimed to build leadership capacity, strengthen behavioural and functional competencies, and promote a culture of continuous learning and citizen-centric governance.

3.0 Details of Food Handlers Training from 01.01.2025 To 12.12.2025

Between January 1, 2025, and December 12, 2025, a total of 14,206 training sessions were conducted, imparting skills to 7,90,599 food handlers. The initiative primarily focused on Food Safety Supervisors, with 12,528 sessions covering 6,16,783 individuals. Additionally, 1,73,816 Street Food Vendors were trained across 1,651 sessions, while institutional capacity was strengthened through 37 Training of Trainer (ToT) sessions attended by 717 participants.

FoSTaC Training of Trainers Program (ToT) on Advance Catering held on 13.02.2025 in Thiruvananthapuram, Kerala

Street food vendor training program organized by SRO in Telangana on 18.09.2025

FoSTaC Training of Trainers Program (ToT) on Street Food Vending held on 26.11.2025 for Food Safety Officers of FDA at Kolkata, West Bengal.

Street Food Vendors Training Programme on 28.11.2025 at the Lok Sabha constituency of Haridwar under the Food Safety Training and Certification (FoSTaC) initiative in collaboration with the State Food Safety

Trainings conducted in 2025 at NTCFSS, Ghaziabad

As part of the 'Lok Kalyan Mela' under PM SWANIDHI scheme organized by Ministry of Housing & Urban Affairs , FSSAI SRO has organised street food vendor training program at Telangana on 18.09.2025.This training program marked the start of 2 week long street food vendor training in various states of South India. Training was conducted by the FSSAI empaneled training partner M/s DCI Multiskills Pvt Ltd and was attended by 281 street food vendors in Medchal, Khammam and GHMC urban local bodies of Telangana.

FoSTaC Training of Trainers (ToT) program on Basic Catering General held on 12.12.2025 inVijayawada, Andhra Pradesh.

Third Global Food Regulators Summit (GFRS) 2025

(26th to 27th September 2025)

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The Global Food Regulators Summit (GFRS) is an initiative of the Food Safety and Standards Authority of India (FSSAI), under the aegis of the Ministry of Health and Family Welfare (MoH&FW), Government of India. Designed as a platform for international food regulators and policy-makers, the summit fosters the exchange of best practices, regulatory insights, and innovations aimed at strengthening food safety systems across the global food value chain.

Following the success of the previous editions in 2023 and 2024, FSSAI organized the 3rd GFRS 2025 from 26th to 27th September 2025, at Bharat Mandapam, New Delhi, as part of the World Food India (WFI 2025) event organized by MoFPI.

1.0 Leadership and Inaugural Vision

The opening session of the 3rd GFRS was inaugurated by **Shri Jagat Prakash Nadda**, Hon'ble Union Minister of Health and Family Welfare and Minister of Chemicals and Fertilizers. In his address, he stated that food safety is a shared global responsibility and spoke about the theme **"Yatha Annam Tatha Manah"** (As is the food, so is the mind), emphasizing the connection between food and health. He also shared the Hon'ble Prime Minister's vision for a healthier India, specifically the appeal to reduce edible oil consumption by 10%. This initiative, along with the promotion of traditional dietary practices, underscored the goal of connecting nutrition with holistic well-being.

During the valedictory session, **Shri Prataprao Ganpatrao Jadhav**, Hon'ble Union Minister of State (Independent Charge) of the Ministry of Ayush and Minister of State in the MoH&FW, delivered the speech as chief guest (virtually), reiterating the importance of integrating traditional wisdom with modern science.

2.0 Technical Sessions and Thematic Focus

A key highlight of the summit was a series of eight technical sessions featuring senior regulatory officials and experts from **FAO, WHO, Codex, and WTO**. These sessions moved beyond general policy to address specific, high-tech regulatory challenges:

- **Global Regulatory Harmonization & Policy Frameworks:** The session highlighted the importance of Global Regulatory framework and challenges, issues and approaches in Regulatory Harmonization.
- **Integrating Science and Technologies towards Sustainable Food Systems:** The session is important as the world needs a unified approach to tackle the environmental and health challenges posed by food wastage, packaging, plastic waste and microplastic contamination.
- **Dynamic Food Landscape – A Need for Pragmatic Approach:** The session highlighted Regulatory Pathways for Emerging Food Technologies and in depth discussion was held.

- **Traditional Foods & Global Standards:** Centered on India's Ayurved Aahar regulations, this theme focused on creating global benchmarks for traditional foods to ensure authenticity while meeting international safety and labeling requirements.
- **Harnessing Digital Systems for Intelligent Surveillance and Proactive Risk Management:** This session explored how systems like FoSCoS and InfolNet are transitioning regulators from reactive enforcement to proactive risk management. Experts discussed using AI and Machine Learning to reduce laboratory testing turnaround time.
- **Empowering Regulators: Next-Generation Skills for a Complex Food System:** This session provided insights into the emerging challenges faced by food regulators and helped to identify the best use of modern technologies for skill development with the aim of transforming and harmonizing the food regulatory landscape globally.
- **Driving Food Safety: Through Public Private Sector Engagement:** this session explored strategic models that create long-term value for regulators, industry, and consumers by building trust, reducing risks and ensuring sustainability across the food value chain.
- **Combating Obesity:** Nutrition, Fitness and Consumer Awareness: Addressing the "silent epidemic" of obesity through nutrition literacy and the role of front-of-pack labeling in helping consumers make informed choices.

Beyond these themes, the sessions included specific discussions on the regulation of bio-manufactured foods, with experts noting the need for mutual recognition of equivalence between countries to avoid trade duplication. Another focus was the Ayurveda Aahara Regulations, which provide a scientific framework for validating and integrating traditional Indian foods into the global safety system. Experts from the WTO shared insights on risk analysis findings from recent dispute settlement cases, providing a look at how safety standards affect international trade law.

3.0 Strategic Initiatives and Digital Empowerment

Eat Right Thali Book was launched during the opening session of GFRS 2025. It celebrates India's culinary heritage through traditional thalis from all 29 states, showcasing balanced regional meals that reflect local ingredients, cooking techniques, and dietary wisdom.

Digital Ecosystem Empowerment: The summit highlighted the success of India's digital platforms, such as FoSCoS (Food Safety Compliance System). These tools have streamlined licensing for millions of food business operators and reduced laboratory testing times, moving the regulatory process toward proactive safety management.

Launch of FSSAI-WHO Master Class Program in Food Safety & Risk: Under the theme CODEX and WHO Frameworks, Principles & Tools, this program was introduced to enhance technical capacity among global regulators, focusing on scientific risk assessment and international safety standards.

4.0 Bilateral Cooperation

On the sidelines of 3rd GFRS 2025, several activities were conducted:

- The Ambassadors' Conclave: Focused on International Cooperation for cohesive food regulation.
- RoundTable Dialogue (MSMEs/Startups): Theme: Strengthening Food Safety Culture in MSMEs.
- CEO Conclave: Theme: Responsible Food Systems – Compliance & Consumer Trust.
- Bilateral Meetings: Meetings were conducted with New Zealand and Russia to discuss future areas of cooperation in the field of food safety.

5.0 Conclusion

The 3rd Global Food Regulators Summit reaffirmed India's commitment to a safer, more resilient, and inclusive global food ecosystem. By bringing together stakeholders from across the world, FSSAI has set a precedent for collaborative regulatory action. As the global dialogue continues, initiatives like GFRS serve as instruments for building harmonized standards and shared responsibility in ensuring the health of consumers worldwide.

QUIZ ON CLAIMS

1. What is a "nutrition claim"?
A. A claim suggesting treatment or cure of a disease
B. A statement about the taste or colour of food
C. A representation stating or implying a food has particular nutritional properties
D. A mandatory declaration in the ingredient list
Correct answer: C

2. Which of the following is an example of a nutrient content claim?
A. 30% less sugar than regular biscuits
B. Contains as much calcium as milk
C. High in dietary fibre
D. May reduce the risk of heart disease"
Correct answer: C

3. Nutrient content claims are best described as:
A. Comparative and relative
B. Absolute and non-comparative
C. Based on consumer perception
D. Allowed without any conditions
Correct answer: B

4. What defines a nutrient comparative claim?
A. It highlights absence of an ingredient
B. It compares nutrient levels between similar foods
C. It explains the function of a nutrient in the body
D. It refers to disease prevention
Correct answer: B

5. Which of the following is a valid nutrient comparative claim?
A. Healthier than other brands
B. Low sugar
C. 30% less sugar than regular biscuits
D. Sugar-free taste
Correct answer: C

6. For a nutrient comparative claim, the minimum difference for macronutrients must be:
A. 10%
B. 15%
C. 25%
D. 30%
Correct answer: D

7. What is an equivalence claim?
A. A claim comparing two brands
B. A claim stating identical taste
C. A claim suggesting similar nutrient content between two foods
D. A claim about nutrient absence
Correct answer: C

8. Which of the following is an equivalence claim?
A. Low calcium
B. Contains as much calcium as a glass of milk
C. Rich source of vitamins
D. Supports bone health"
Correct answer: B

9. What does the claim "No added sugar" mean?
A. The product contains no sugar at all
B. Artificial sweeteners are added
C. No sugars or sugar-containing ingredients are added
D. The product is low calorie
Correct answer: C

10. If naturally occurring sugars are present, which statement is correct?
A. Sugar-free
B. Naturally sweet
C. Contains naturally occurring sugars
D. Low glycaemic food"
Correct answer: C

11. When can a product claim "No added salt"?
A. When sodium content is low
B. When no sodium salts or substitutes are added
C. When taste enhancers are used
D. When compared to regular foods
Correct answer: B

12. Which statement best describes a nutrient function claim?

A. It compares two foods
B. It claims disease prevention
C. It describes the role of a nutrient in normal body functions
D. It highlights absence of an ingredient
Correct answer: C

13. Which of the following is a nutrient function claim?

A. Low cholesterol food
B. Calcium is needed for maintenance of normal bones
C. Reduces heart disease
D. Doctor recommended"
Correct answer: B

14. Other function claims:

A. Always refer to disease cure
B. Do not require scientific evidence
C. Describe benefits beyond basic nutrition
D. Are the same as nutrient content claims
Correct answer: C

15. Which is an example of an "other function claim"?

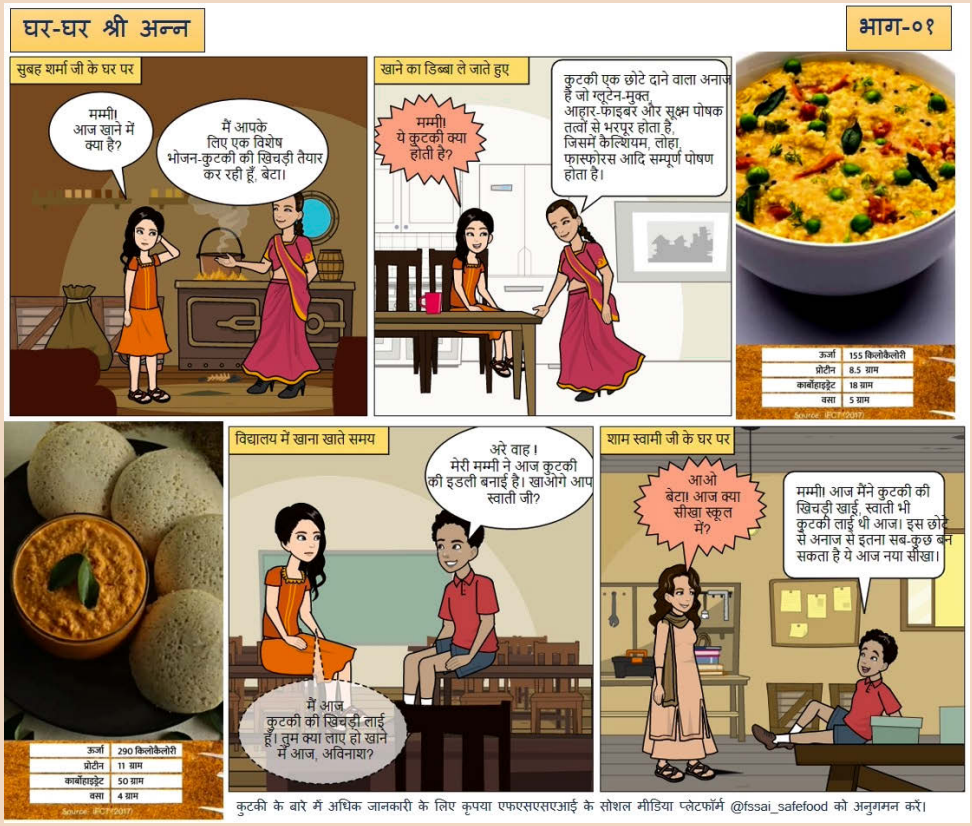
A. High protein
B. Beta-glucans help reduce the rise in blood glucose after a meal
C. No added sugar
D. Low fat
Correct answer: B

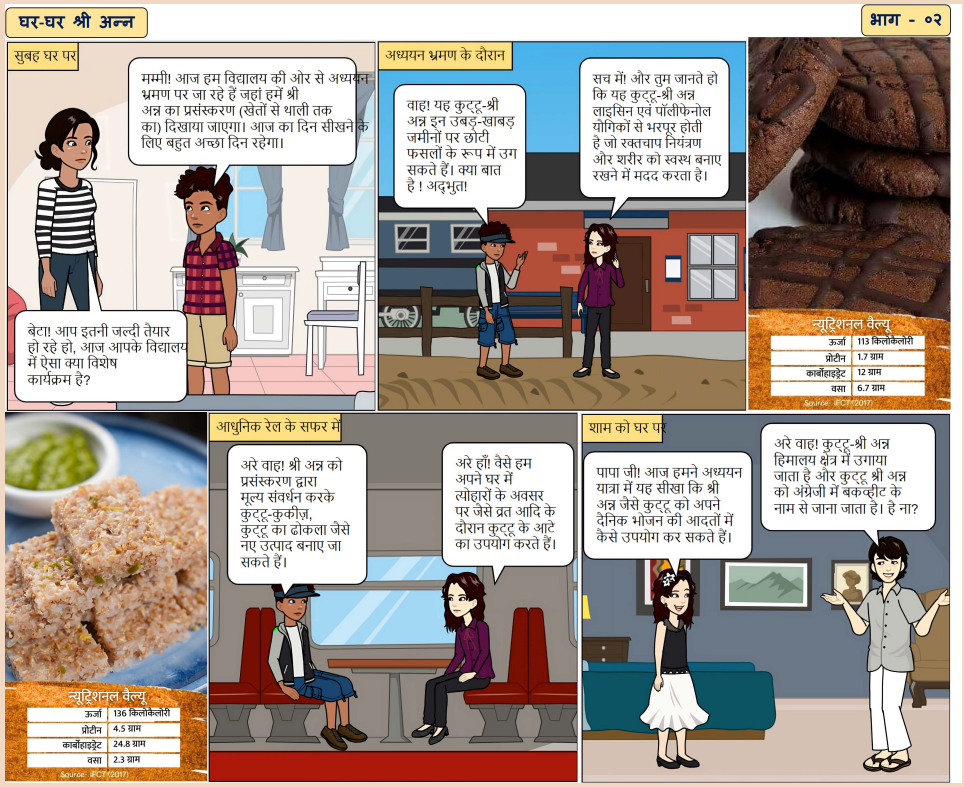
16. What is a disease risk reduction claim?

A. A claim to cure a disease
B. A claim reducing a disease symptom
C. A claim suggesting reduction of a risk factor for a disease
D. A claim related to taste improvement
Correct answer: C

17. Which statement is a disease risk reduction claim?

A. Cures high blood pressure
B. Prevents heart disease
C. Diets low in sodium may help reduce the risk of high blood pressure
D. Low sodium taste
Correct answer: C



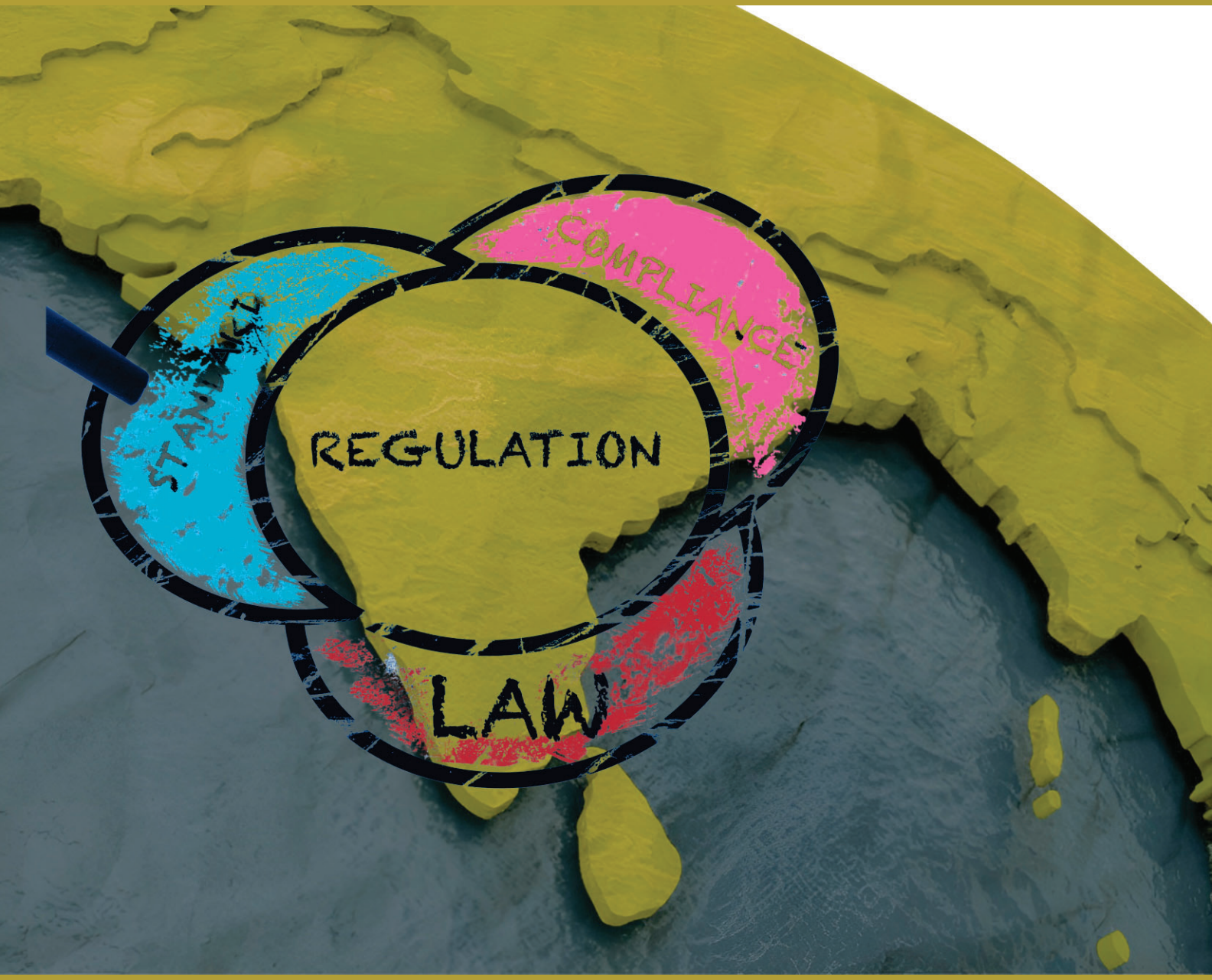


CREATIVE FORUM

Selvaraj Ajay Vino is Technical Officer at the Food Safety and Standards Authority of India (FSSAI), New Delhi. He envisions *Ayurveda Aahara* extending its reach across the nation. His artworks disseminate *Ayurveda* aspects of personalised choice of living a healthy life with a safe food ecosystem, thus enabling consumers to make informed choices.

आहारशुद्धौ सत्त्वशुद्धिः सत्त्वशुद्धौ ध्रुवा स्मृतिः।

(Chandogya Upanishad 7.26.2)



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स्निग्धाः स्थिरा हृद्या आहाराः सात्त्विकप्रियाः॥

(श्रीमद्भगवद्गीता १७.८)

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