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Food safety challenges in poultry meat production: from farm to processing

Abstract

Poultry meat has emerged as one of the fastest-growing sources of animal protein in India, due to rapid urbanization, changing dietary habits and rising incomes. Owing to its affordability, wide acceptance, and high nutritional value, poultry meat plays a crucial role in meeting the protein needs of a growing population. India currently ranks among the leading producers of eggs and broiler meat globally. However, ensuring food safety during poultry meat production remains a major challenge, particularly across the stages from farm management to processing and distribution. This review examines key food safety challenges associated with poultry meat production, with emphasis on on-farm practices, disease control, use of antimicrobials, hygienic slaughter, and processing operations. Common microbial hazards, including foodborne pathogens, are discussed along with factors contributing to contamination during handling, processing, packaging, and cold chain maintenance. The review also highlights gaps in biosecurity, infrastructure, and compliance with existing food safety standards, especially in small-scale and informal production systems. Current regulatory frameworks and food safety guidelines relevant to poultry processing in India are briefly outlined to provide context. The importance of good farming practices, hazard identification, sanitation, temperature control, and worker hygiene is emphasized as critical to reducing contamination risks. By presenting a farm-to-processing perspective, this review aims to enhance understanding of food safety challenges in poultry meat production and support efforts toward safer, more sustainable poultry processing systems. Overall, the review presents the need for improved awareness, better coordination among stakeholders, and adoption of science-based safety practices to ensure safe poultry meat for consumers.

Keywords: foodborne pathogens, poultry meat, meat safety, haccp, India

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Introduction

Poultry meat has emerged as the fastest-growing component of animal protein in India. With rising incomes, urbanization, and changing consumer preferences, poultry meat is increasingly recognized as an affordable, high-quality protein source. India ranks 2nd in the world in terms of total egg production and 5th globally in meat (broiler) production (BAHS, 2024; FAO). As per last livestock census, total poultry population is 851.8 million. Today, it accounts for nearly 48.96% of total meat production in the country. Egg output rose substantially from 78.48 billion in 2014–15 to 138.38 billion in 2022-23 and to 142.77 billion in 2023–24, driven by a compound annual growth rate (CAGR) of approximately 6.87%. The egg production has increased by 3.17% in 2023-2024 as compared to the previous 2022-2023 year. The total egg production from commercial poultry is 114.92 billion eggs, and from backyard poultry is 2.7 billion eggs, contributing 80.49% and 19.50% of the total egg production, respectively. The per-capita availability of eggs is 103 eggs per annum, contributing significantly to national food security. The total egg production in India is 142.77 billion nos. The top 5 eggs producing States are Andhra Pradesh (17.85%), Tamil Nadu (15.64%) Telangana (12.87%), West Bengal (11.37%) and Karnataka (6.62%). These states together contribute 64.37% of the total egg production in the country. Despite this impressive growth, ensuring the safety and quality of poultry meat from farm to consumer remains a critical challenge, particularly under the One Health framework that links human, animal, and environmental well-being. The estimates of meat and egg production are given in Table 1.

Table 1 Current status of egg and poultry meat production in india (bahs, 2024)

Serial number	Current metrics (2023-2024)	Rank/values
1.	Global Egg Production Rank	2nd Globally
2.	Egg Production	142.77 billion
3.	Per Capita Egg Availability	103 eggs/year
4.	Global Meat Production Rank	5th in the world
5.	Meat Production	10.25 million tonnes

In the past two decades, poultry farming in India has transformed from backyard flocks into a modern agribusiness. Poultry meat alone contributes nearly half of India's total meat output, making it the backbone of affordable protein security. Demand is driven by urbanization, rising incomes, and the fact that poultry is free from many cultural and religious restrictions that limit other meats. India exported 1.275 million tons of poultry products in FY 2023–24, valued at USD 184.6 million. The primary destinations for these exports were Oman, Sri Lanka, Maldives, UAE, and Qatar, according to data from APEDA.[1] Although exports have nearly doubled in recent years, India captures only a small share of the global poultry trade due to limitations in infrastructure, compliance with sanitary standards, and brand competitiveness.

Constraints affecting export of poultry

India's poultry industry holds considerable potential for international trade; however, several export constraints continue to

restrict its growth and global competitiveness. These challenges are multi-dimensional, ranging from infrastructure limitations to trade barriers and input cost volatility.

I. Limited processing infrastructure

A significant limitation lies in the shortage of **processing facilities th**at comply with international sanitary and phytosanitary (SPS) standards. While India has made strides in modernizing its poultry sector, a large proportion of poultry meat is still marketed in wet markets, with minimal chilling or hygienic processing. This makes it difficult to meet the stringent requirements of high-value importing countries such as the European Union, Japan, and the United States, where traceability, pathogen control, and cold chain integrity are non-negotiable. The lack of sufficient Hazard Analysis and Critical Control Points (HACCP)-certified units further weakens export preparedness.

II. Weak brand credibility and limited product diversification

Globally, poultry exports are not just about frozen cuts but also about value-added diversification such as marinated products, ready-to-cook/ready-to-eat lines, and specialty health oriented items (e.g., organic or antibiotic-free chicken). In contrast, India's export portfolio remains concentrated around table eggs, egg powder, and limited frozen meat cuts**,** creating an image of low diversification and limited innovation. This weak brand credibility undermines India's ability to penetrate premium markets, where branding and certification (such as "organic" or "free-range") often command higher prices.

III. Traceability issues

Lack of robust traceability systems linking farms, feed sources, processing units, and distribution undermines consumer trust and fails to meet strict international buyer requirements. This gap weakens India's global competitiveness, as traceability is now considered a non-negotiable standard in high-value markets.

IV. Trade barriers and tariff disadvantages

India's poultry sector has also suffered from tariff-based disadvantages in the past. For example, Japanese import duties on Indian egg powder were higher compared to those imposed on competitors like Mexico, which led to a loss of competitiveness and market share. Such disparities have discouraged exporters from aggressively investing in developing niche poultry product markets overseas. Non-tariff barriers, such as requirements for disease-free certification (e.g., avian influenza-free zones), further add to the trade challenges.

V. Feed cost volatility

The economics of poultry exports are highly sensitive to feed cost fluctuations. Feed accounts for **60–70% of total broiler production costs,** and the dependence on maize and soybean makes the sector vulnerable to global and domestic price shocks. Price spikes not only erode domestic profitability but also reduce export viability in price-sensitive global markets. For example, when maize prices rise sharply due to climate fluctuations or export restrictions, Indian poultry exporters find it difficult to match the competitive pricing of countries like Brazil or the United States, which benefit from more stable feed supply chains.

VI. Policy and structural challenges

Despite policy support from APEDA and DAHD, a lack of dedicated poultry export zones, disease surveillance networks, and international certification mechanisms limits India's capacity to project itself as a reliable global supplier.[2] Furthermore, the fragmented nature of the domestic poultry industry with many small and medium industries makes standardization difficult.[1]

If we talk in Indian context, on one hand, integrated companies supply chilled and frozen chicken in branded packs through supermarkets and e-commerce. On the other, a majority of Indians still prefer to buy live birds, slaughtered on the spot in small neighborhood shops. This dual system modern cold-chained supply alongside traditional live-bird markets creates uneven safety outcomes. This paper discusses the current status of poultry meat in India, safety requirements across production, processing, and packaging levels, the regulatory framework governing feed and food safety, challenges in marketing and cold chain infrastructure, and policy recommendations for the future. This paper brings together the current status of poultry meat in India, the safety requirements at various stage of production, processing, and packaging, and the regulations that guide them. It also highlights the less visible links, such as animal feed safety, live-bird markets, cold chain gaps, and consumer handling, that decide whether meat remains wholesome or becomes a source of risk. Finally, it reflects on the challenges and proposes future recommendations for strengthening India's poultry safety policies in a way that balances public health, farmer livelihoods, and consumer trust. Ensuring the safety of poultry meat requires not only good farm and processing practices but also a strong regulatory backbone. In India, this framework is guided by a comprehensive legal structure through Food safety regulations that governs production, processing, and distribution.

Food Safety Regulations**-** Food safety in India is anchored in the Food Safety and Standards Act, 2006 and regulations framed under it. For poultry meat, the most relevant are:

I. **Schedule 4 of the licensing & registration regulations (2011):** This schedule lays down essential hygiene and sanitation practices for slaughterhouses and poultry processing units, covering facility design, waste management, worker hygiene, and cleaning protocols. Its implementation ensures that contamination risks are minimized at the primary processing stage.

II. **Food product standards & additives regulations (2011):** These regulations prescribe compositional and safety standards for poultry meat and products, including limits for microbial counts, permitted additives, and quality parameters. By setting uniform benchmarks, they ensure consumer protection and fair trade in the poultry sector.

III. **Contaminants, toxins & residues regulations (2011):** This framework establishes maximum residue limits (MRLs) for veterinary drugs, pesticides, heavy metals, and other contaminants in poultry meat. Enforcing these standards safeguards public health by minimizing risks of antimicrobial resistance and toxic exposure.

IV. **Labeling & display regulations (2020):** These rules mandate clear, accurate, and consumer-friendly labeling on poultry products, including information on ingredients, allergens, storage, and expiry. Transparency in labeling empowers consumers to make informed choices and enhances market accountability.

V. Evolving regulations on animal (poultry) feed practices: Aligned with Bureau of Indian Standards (BIS), these directions ensure that poultry feed is free from contaminants such as aflatoxins, heavy metals, and adulterants. Safe feed directly

impacts poultry health and reduces downstream risks of unsafe residues in meat. The Bureau of Indian Standards (BIS) has formulated voluntary standards for animal feeds, including poultry feed, and producers are encouraged to comply with these standards and obtain ISI certification as a mark of quality assurance. In the case of organic or specialty feeds, producers may also adhere to the National Programme for Organic Production (NPOP) guidelines of APEDA, particularly when catering to export markets.

VI. **FSSAI guidelines for egg safety and quality**: The Food Safety and Standards Authority of India (FSSAI) released guidelines for egg safety and quality in April 2019, which provide guidance on storing, handling, and testing eggs.

VII. **Stricter antibiotic residue norms**: FSSAI revised antibiotic residue norms for eggs, poultry, and other food products, with the new limits coming into effect from April 1, 2025.

VIII. **Egg registration and marking**: Although the exact date isn't specified, the National Egg Co-Ordinating Committee (NECC) regulations require eggs to be marked with a code given by NECC, and laying hens must be registered and allocated a distinguishing number

Together, these rules & regulations aim to cover the journey from feed to fork. The challenge lies less in drafting them and more in ensuring they are applied consistently across India's highly diverse poultry sector. Hence, various critical control points have been identified to ensure the safety at different levels.

Critical control points to address the safety targets-

I. Primary production

The foundation of safe poultry meat lies in safe and responsible farming practices. Key measures include access to clean drinking water, proper litter management, vaccination, and stringent biosecurity to minimize pathogen entry and spread. Poultry farms are particularly vulnerable to pathogens such as *Salmonella spp*. and *Campylobacter jejuni*, both leading causes of foodborne illness worldwide.[3] In addition, *Escherichia coli and Listeria monocytogenes* may contaminate poultry meat during farm-to-fork handling. Viral infections like Avian Influenza (H5N1, H5N2) pose zoonotic threats, while fungal contaminants such as *Aspergillus flavus* can introduce aflatoxins through feed. Contaminated or improperly formulated feed is a silent carrier of toxins, heavy metals, and antibiotic residues. Parasites such as *Eimeria spp*. (coccidia) also impair gut health, predisposing birds to secondary bacterial infections. Feed is a hidden but critical element: contaminated or poorly formulated feed can introduce mycotoxins, pesticide residues, or even antibiotic-resistant bacteria. Moreover, misuse of antimicrobials without observing recommended withdrawal periods contributes to antimicrobial resistance (AMR) and residue accumulation in meat. Therefore, farm-level preventive strategies form the first critical control point to ensure consumer-safe poultry products.

II. Abattoir operations

Poultry slaughter is a critical point where microbial contamination peaks. Scalding water, defeathering machines, and evisceration steps are hotspots for the spread of pathogens. Improper evisceration may rupture intestines, contaminating carcasses with *Salmonella*, *Campylobacter*, or *Clostridium perfringens*. Hygienic handling, sanitized equipment, and potable water for washing carcasses are essential.[4] Workers hygiene and protective gear also play an important role in reducing cross-contamination.

III. Processing & packaging

Processing plants introduce additional hazards. Chilling water, if not regularly treated, becomes a reservoir for pathogens. Cross-contamination occurs on conveyor belts, knives, and packaging surfaces. *Listeria monocytogenes*, in particular, thrives in cold, damp environments and poses a serious risk to ready-to-eat poultry products. Monitoring temperature, enforcing sanitation schedules, and using Hazard Analysis Critical Control Point (HACCP) guidelines are indispensable. Figure 1

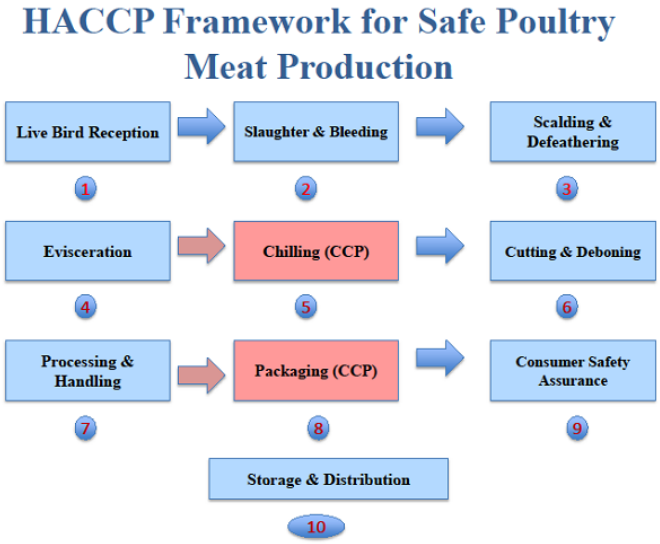

Figure 1 From farm to fork- haccp in poultry processing and packaging.

IV. Transport and storage

Despite safe processing, failures in cold chain management may negate prior safety measures. Meat must be transported at ≤4°C and frozen products at ≤-18°C to prevent bacterial multiplication. Non-refrigerated or improperly insulated vehicles facilitate the growth of *Salmonella*, *Listeria*, and *E. coli*. Clean containers, regular disinfection of transport vehicles, and trained handlers are crucial to maintain safety during distribution.

V. At retail and consumer level

The final safety checkpoint lies with retailers and consumers. Improper display at ambient temperatures, repeated thawing and refreezing, and poor personal hygiene of handlers all elevate risks. Wet markets are particularly vulnerable, with *Campylobacter* and *Salmonella* thriving in warm, moist environments. Educating retailers about hygiene, enforcing standards for cold display, and consumer awareness on safe handling and cooking of poultry are key points to minimizing health hazards.

VI. Marketing channels diversity, cold chains, and consumer

In India, marketing channels for poultry meat are highly fragmented, ranging from live-bird markets and small neighborhood retailers to organized supermarkets and e-commerce platforms. For many consumers, live-bird shops are perceived as more "trustworthy" since they can visually assess the bird before slaughter. However, these informal markets often lack basic infrastructure such as running water, hygienic slaughter areas, proper waste disposal, and refrigeration facilities, creating an environment conducive to cross-

contamination with pathogens like *Salmonella* and *Campylobacter*. In contrast, cold chain systems, which include refrigerated transport, cold storage, and retail display units are fundamental to maintaining carcass hygiene, inhibiting microbial growth, and extending shelf life. Although India has significantly invested in cold chain infrastructure in recent years, substantial gaps persist, particularly at the last mile of distribution. Small retailers frequently face challenges of unreliable electricity supply, inadequate maintenance of display cabinets, and inconsistent temperature monitoring. Consequently, even when meat leaves processing plants under optimal safety conditions, subsequent lapses in cold chain management and marketing practices can compromise product quality and consumer safety.

Finally, consumers themselves play a role. Safe thawing, correct refrigeration at home, and thorough cooking are often overlooked in everyday practice.

Challenges that need urgent attention

I. **Feed safety not fully enforced:** Although BIS and FSSAI guidelines for poultry feed exist, many small-scale feed mills and backyard farms escape strict monitoring. This opens the door to mycotoxins, pesticide residues, and even antibiotic carryover, which ultimately affect both bird and consumer health.

II. **Live bird market hygiene:** Cultural preference for freshly slaughtered birds sustains live-bird markets, but these hubs often lack running water, sanitation, and proper waste disposal. Such unhygienic practices amplify the risks of Salmonella, Campylobacter, and avian influenza transmission.

III. **Small processors left behind:** Large integrated poultry companies can afford HACCP systems, certification, and testing facilities, but small and medium processors struggle with costs, infrastructure, and expertise. As a result, they remain highly vulnerable to regulatory non-compliance and food safety lapses.

IV. **Cold chain weak links:** While India has invested in large-scale cold storage and transport, local distribution often relies on unreliable electricity and poorly maintained refrigerators. In retail, temperature abuse is common, leading to microbial growth despite initial safe processing.

V. **Consumer awareness:** Many consumers buy unpackaged chicken without refrigeration or labeling, often unaware of safe handling, cooking, and storage practices. This lack of awareness perpetuates foodborne infections and undermines national food safety campaigns.[5]

Conclusion

India has emerged as one of the world's leading poultry producers, standing 2nd in global egg production and 5th in broiler meat output. While this rapid expansion has strengthened national food and nutrition security, it also brings complex food safety challenges spanning feed quality, farm biosecurity, processing hygiene, cold-chain integrity, and consumer practices. Ensuring poultry meat safety from farm to fork therefore requires a coordinated One Health approach, integrating animal health, public health, and environmental safeguards. Strengthening regulatory enforcement under FSSAI, upgrading infrastructure for hygienic slaughter and scientifically managed live-bird markets, expanding HACCP and traceability systems, and improving cold-chain networks are essential to minimize microbial contamination and residue risks.[6] Investment in feed quality monitoring, farmer training, disease surveillance, and AMR stewardship will further enhance the reliability of India's poultry value chain. Finally, increasing consumer awareness about safe handling and cooking practices is equally important to reduce the burden of foodborne infections. By combining science-based policies with practical ground-level implementation, India can ensure that its rapidly growing poultry sector remains safe, sustainable, and globally competitive supporting both public health and economic development.

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Conflicts of interest

The authors declare there are no conflicts of interests to declare.

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