Animal Health Research Journal

P-ISSN : 2356-7767 On Line-ISSN : 2535-1524
Journal Homepage: https://animalhealth.ahri.gov.eg/ Review Article

Mycotoxins' impacts on poultry health, meat safety and quality within a One Health Framework

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Received in 7/7/2025
Received in revised from 20/8/2025
Accepted in 29/9/2025

Keywords:
Mycotoxins,
Poultry health,
Meat safety,
Meat quality,
One Health,
Egypt.

Abstract

Mycotoxins, the toxic secondary metabolites produced mainly by *Aspergillus*, *Fusarium*, and *Penicillium* species, represent one of the most significant challenges to poultry production and food safety worldwide. Contamination of poultry feed with mycotoxins not only impairs bird health and productivity but also compromises meat quality and consumer safety. These toxins are associated with immunosuppression, impaired growth performance, organ toxicity, and increased susceptibility to infectious diseases in poultry. Moreover, residues or toxic metabolites may accumulate in edible tissues, posing risks of carcinogenicity, hepatotoxicity, and nephrotoxicity to humans. The impacts extend beyond animal and human health, influencing global trade and food security. This review synthesizes current knowledge on the occurrence and types of mycotoxins in poultry feed, their impacts on poultry health and meat safety, and their implications for public health. It also highlights recent advances in control and mitigation strategies, as well as research gaps and future perspectives, with emphasis on integrated approaches for ensuring poultry productivity and food safety within a One Health framework.

Introduction

Mycotoxins are a diverse group of low-molecular-weight primarily produced by fungi belonging to the genera *Aspergillus*, *Fusarium*, and *Penicillium* **(Gurikar *et al.*, 2023).** These compounds are ubiquitous contaminants in agricultural commodities and animal feeds, especially under conditions of poor storage, high humidity, and temperature fluctuations **(Bereda, 2025; Muñoz-Solano & González-**

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Peñas, 2023). The poultry industry is particularly vulnerable to mycotoxin contamination due to the heavy reliance on cereal grains and protein-rich ingredients, which serve as favorable substrates for fungal growth **(Akinmoladun *et al.*, 2025; Pouris *et al.*, 2024).**

The global prevalence of mycotoxins in feedstuffs has become a major concern, as their ingestion by poultry adversely affects health, welfare, and productivity **(Strachan, 2023).** Mycotoxins such as aflatoxins (AFs) and ochratoxins (OTs), trichothecenes (T-2 toxin, deoxynivalenol), **fumonisins (FUM)**, and zearalenone exert a wide range of toxic effects, including hepatotoxic, nephrotoxic, immunotoxic, and carcinogenic impacts **(Okasha *et al.*, 2024).** In poultry, these toxins impair growth performance, feed conversion efficiency, and reproductive capacity, while predisposing birds to infectious diseases due to immunosuppression **(Magembe , 2025; Pouris *et al.*, 2024).** Beyond their effects on live birds, mycotoxins compromise the safety and quality of poultry meat intended for human consumption **(Strachan, 2023; Gómez-Osorio *et al.*, 2024).** Residual toxins or their metabolites may accumulate in edible tissues, raising serious public health concerns **(Kuo *et al.*, 2022).** Alterations in meat quality parameters such as pH, color, tenderness, and shelf life have also been documented **(Gelaye, 2024; Yogeswari *et al.*, 2024).** From a One Health perspective, mycotoxin contamination represents a threat at the animal–human–environment interface, with implications for global food security and international trade **(Aboolo *et al.*, 2025; Okasha *et al.*, 2024).**

Given their widespread occurrence and multifaceted impacts, there is an urgent need for comprehensive evaluations of mycotoxins in poultry production. This review article aims to provide a critical overview of the types and sources of mycotoxins in poultry feed, their impacts on poultry health, meat safety, and quality, as well as the associated risks to public health. It also addresses the current advances in mitigation strategies and highlights future research directions to ensure sustainable poultry production and safe food supply chain.

Types and Sources of Mycotoxins in Poultry Feed

Major mycotoxin classes and producing fungi

The principal mycotoxins relevant to poultry are: **aflatoxins (AFs)** chiefly from Aspergillus spp.; **ochratoxin A (OTA)** from Aspergillus and Penicillium; (**trichothecenes** notably **deoxynivalenol, DON**, and **T-2/HT-2**); **fumonisins (FUM)** and **zearalenone (ZEN)** from Fusarium) **(Magembe, 2025; Strachan, 2023).** These toxins frequently co-occur in cereals and compound feeds, reflecting multi-fungal contamination across the feed chain.

Occurrence patterns and co-contamination

Large, multi-year monitoring shows persistent, global contamination of raw commodities and finished feeds with the six major mycotoxins, with **multi-mycotoxin co-occurrence as the** norm **(Burger, 2022).** Recent surveys (2023–2024) report high detection frequencies for DON and FUM, substantial rates for ZEN and AFs, and lower but non-negligible detection of T-2 and OTA in poultry-relevant matrices **(Casu *et al.*, 2024).** Co-contamination in poultry feeds commonly involves **two to five toxins per sample**, and several datasets indicate **the highest co-occurrence rates in poultry feed** among livestock species **(Pouris *et al.*, 2024).**

Pre-harvest sources (field level)

Field infection of maize, wheat, barley, and sorghum by Fusarium spp. (DON, ZEN, FUM) **(Magembe, 2025; Strachan, 2023)** and Aspergillus spp. (AFs, OTA) is driven by crop genotype–environment interactions, insect damage, drought/heat stress, and rainfall patterns around flowering and maturation **(Awuchi *et al.*, 2022). Climate change**—via warming, heatwaves, altered precipitation, and shifts in fungal biogeography—is reshaping risk maps, favoring thermotolerant species and extending mycotoxin problems into new geographies **(Casu *et al.*, 2024; Bonerba *et al.*, 2024).**

Post-harvest sources (storage and processing)

Post-harvest growth of Aspergillus/Penicillium during **drying, storage, and transport** is a major source of AFs and OTA when moisture control and aeration are inadequate **(Liu, 2022).** Risk escalates with poor silo management, temperature fluctuations, and damaged kernels; compounded feeds can further mix contaminated lots, facilitating **additive or synergistic exposure** to multiple toxins in the final diet **(Strachan, 2023).**

Ingredients at highest risk

Maize and maize by-products: primary vehicles for FUM and DON globally; frequent co-occurrence with ZEN **(Siri-Anusornsak *et al*., 2022).**

Small grains (wheat, barley): important sources of DON/ZEN in broiler and layer diets **(Hamadi, 2022).**

Oilseed meals and alternative ingredients: The level of mycotoxin contamination in oilseed meals and alternative feed ingredients such as dried distillers' grains with solubles (DDGS) is highly variable and strongly influenced by both geographic origin and processing methods. These substrates have the potential to concentrate specific mycotoxins during production, thereby posing a considerable risk to feed and food safety. Patterns of mycotoxin occurrence demonstrate marked regional variation as well as temporal fluctuations, reflecting differences in climatic conditions, crop cultivation practices, storage systems, and seasonal weather dynamics. Continuous monitoring is therefore essential to detect emerging risks and adapt mitigation strategies accordingly**. (Toutirais *et al*., 2024).**

Surveillance indicates **year-to-year variability** tied to crop seasons and weather anomalies; time-series analyses show seasonal clustering and correlations among toxin families. Recent regional updates (e.g., Maghreb, Europe) underscore evolving profiles under changing climate conditions and supply chains **(Platzer *et al*., 2025)**

Regulatory and risk-assessment context

Regulators (e.g., **EFSA**) consistently list AFs, OTA, and Fusarium toxins (DON, ZEN, FUM) as the **mycotoxins of major concern** for animal and human health. EFSA's most recent OTA assessment for animal health (2023) characterizes risk at typical European feed levels as generally low for laying hens, while acknowledging uncertainties and the importance of co-exposure supporting continued monitoring and mitigation (**EFSA, 2023; European Environment Agency, 2024; Platzer *et al*., 2025).**

Table (1). Major mycotoxins relevant to poultry feed: sources, high-risk ingredients, and recent occurrence (selected peer-reviewed evidence)

Mycotoxin	Main producing fungi	High-risk feed ingredients	Recent occurrence (selected peer-reviewed data, 2018–2025)
Aflatoxins (AFB_1 etc.)	*Aspergillus flavus*, *A. parasiticus*	Maize/corn, peanut meal, cottonseed, some oilseed meals	(large survey): detected in ~23% of samples (**Gruber-Dorninger *et al.*, 2019). China (2018–2020)**: AFB_1 detected in 81.9–100% of feed ingredient/complete-feed sample sets (Zhao *et al.*, 2021). Spain (compound feeds, 2019–2020): AFB_1 detected in ~13% of poultry feeds (Muñoz-Solano & González-Peñas, 2023) & (Akinmoladun *et al.*, 2025)
Deoxynivalenol (DON)	*Fusarium graminearum*, *F. culmorum* (type-B trichothecenes)	Wheat, barley, maize, DDGS, middlings	~64% positive **(Gruber-Dorninger *et al.*, 2019).** China (2018–2020): 96.4–100% detection in sampled feeds/ingredients; often high medians **(Zhao *et al.*, 2021).** Spain (2019–2020): DON commonly co-occurs with ZEN; frequent in cereals/compound feeds. **(Akinmoladun *et al.*, 2025)**
Fumonisins (FUM) (FB1, FB2)	*Fusarium verticillioides*, *F. proliferatum*	Maize and maize by-products (DDGS)	~60% positive **(Gruber-Dorninger *et al.*, 2019);** very common in maize/maize-DDGS with high median levels. Regional surveys (various Toxins studies) confirm high prevalence in maize-based feeds.
Zearalenone (ZEN)	*Fusarium graminearum*, *F. culmorum*	Maize, wheat, barley, sorghum, bran	~45% positive **(Gruber-Dorninger *et al.*, 2019).** China (2018–2020): 96.9–100% detection **(Zhao *et al.*, 2021).** Spain (2019–2020): ZEN detected in ~66% of poultry feeds (**Muñoz-Solano & González-Peñas, 2023).** Co-occurs frequently with DON. **(Akinmoladun *et al.*, 2025)**
Ochratoxin A (OTA)	*Aspergillus ochraceus*, *Penicillium verrucosum*	Stored cereals (barley, wheat), finished stored feeds	~15% positive **(Gruber-Dorninger *et al.*, 2019).** Prevalence lower than Fusarium toxins but increases with poor storage; regional surveys show occasional samples above guidance.
T-2 / HT-2 (trichothecenes type A)	*Fusarium sporotrichioides*, *F. poae*	Oats, barley, wheat, maize (region-dependent)	~19% detected **(Gruber-Dorninger *et al.*, 2019).** Less frequent but highly toxic; occurrence reported in regional feed surveys and co-occurrence studies.

Growth Performance and Feed Efficiency

Aflatoxins (AFs) and ochratoxin A (OTA) are particularly associated with reduced body weight gain, impaired feed conversion ratio (FCR), and poor carcass yield (EFSA, 2020; Muñoz-Solano & González-Peñas, 2023). Subclinical contamination often results in economic losses due to decreased growth rates and higher feed costs per unit of meat produced **(Akinmoladun *et al.*, 2025).**

Immunosuppression and Disease Susceptibility

Mycotoxins such as fumonisins (FUM), AFs, and trichothecenes suppress both humoral and cell-mediated immunity, rendering poultry more susceptible to bacterial, viral, and parasitic infections **(Casu *et al.*, 2024; Bonerba *et al.*, 2024).** This immunotoxicity contributes to vaccine failures and increases the need for antimicrobial interventions, further complicating flock management.

Gastrointestinal and Organ Pathology

Mycotoxin exposure disrupts intestinal barrier function, alters microbiota balance, and causes lesions in the gut, which impair nutrient assimilation (dsm-firmenich, 2024a, 2024b). Hepatotoxic and nephrotoxic effects, particularly from AFs and OTA, have been extensively reported, leading to liver enlargement, bile duct proliferation, and renal damage in broilers and layers **(EFSA, 2023; European Environment Agency, 2024).**

Reproductive and Egg Production Effects

In laying hens and breeders, chronic exposure to zearalenone and AFs can disrupt reproductive hormones, reduce egg production, and impair eggshell quality **(Muñoz-Solano & González-Peñas, 2023).** This not only decreases flock productivity but also negatively affects hatchability and chick viability.

Synergistic Effects of Co-contamination

A major concern in poultry production is the simultaneous occurrence of multiple mycotoxins in feed. Co-exposure often leads to additive or synergistic toxicity, amplifying negative effects on performance, immune function, and tissue residues **(Akinmoladun *et al.*, 2025; dsm-firmenich, 2024a).** This reality underscores the importance of comprehensive monitoring rather than targeting single toxins in feed analysis.

Table (2). Impacts of Aflatoxin B_1 and Ochratoxin A on Poultry Health and Performance in Egypt

Mycoxins detected	Incidence / Levels	Observed / Reported Impacts on Poultry	Study / Location
AFB_1, OTA	AFB_1 in 52–64% (0.5–62 ppb), OTA in 45–50% (3–52 ppb)	Reduced feed efficiency, growth retardation, immunosuppression; risk of residues in tissues.	**MAHMOUD & MOHAMED (2016),** Dakahilia Governorate
AFB_1, OTA	Aflatoxin: feed 15.3%, litter 30%, sera 20%; OTA: feed 11.5%, litter 18.6%, sera 4%	Broiler poor performance, increased disease susceptibility, presence of residues in sera indicates systemic exposure.	**Hegazy *et al.* (2022),** Egypt (multiple farms)
AFB_1, OTA	Summer: 100% contamination with AFB_1 & OTA; 66% OTA > safe limits	Higher summer risk, linked to immunotoxicity and mortality; OTA > limits associated with nephrotoxicity.	El-Behaira Province **(Al-Said & El-Tedawy, 2021)**
AFB_1	Experimental contamination of feed	Induced liver damage, oxidative stress, poor growth; Nano-curcumin ameliorated negative effects.	**Hamouda *et al.* (2025),** Experimental trial
A. flavus (aflatoxin producers)	62.5% samples contaminated; 57.3% strains toxigenic	Indicates high environmental risk of aflatoxicosis in poultry; associated with reduced productivity.	Beni-Suef **(Hassan *et al.*, 2021)**
AFB_1, AFG_1	Residues in poultry meat	Public health risk; related to reduced immunity and child growth problems.	Damanhur **(El-Kewaley *et al.*, 2014)**
OTA	Residues: kidney > liver > muscle (within limits)	Altered liver/kidney enzymes, oxidative stress, potential chronic effects despite being within permissible levels.	OTA Residue Study **(Mostafa *et al.*, 2021)**

Impacts on Poultry Health and Performance

Mycotoxin contamination in poultry feed poses a significant threat to poultry health, productivity, and food safety, particularly in developing regions such as Africa, where climatic conditions, storage infrastructure, and monitoring systems increase the risk of contamination **(Akinmoladun *et al.*, 2025; Gelaye, 2024).** In poultry, exposure to aflatoxins (AFs) and ochratoxins (OTs), **fumonisins (FUM)**, and other toxins has been associated with impaired growth performance, immunosuppression, increased disease susceptibility, and organ damage **(Okasha *et al.*, 2024).** These negative outcomes not only affect animal welfare but also compromise economic returns for poultry producers.

In Egypt, feed contamination by Aspergillus and Penicillium spp. is widely documented. A recent mycological survey conducted in El-Behaira Province confirmed the frequent detection of aflatoxins (AFs) and ochratoxins (OTs) in poultry feed samples, with direct consequences on flock performance and health **(Alnaemi *et al.*, 2023; Al-Said & El-Tedawy, 2021).** Birds consuming contaminated feed exhibited reduced body weight gain, poor feed conversion ratios, and increased morbidity rates **(Mohamed *et al.*, 2024).** This reflects the broader regional challenge in Africa, where hot and humid climates provide favorable conditions for mycotoxin-producing fungi **(Putra *et al.*, 2024; Mgbeahuruike *et al.*, 2023).**

Pathological findings from both experimental and field studies highlight the severity of these toxins **(Tahir *et al.*, 2022).** For example, ochratoxin A (OTA) exposure in poultry has been associated with hepatomegaly, nephropathy, and immunosuppression, leading to secondary bacterial infections and reduced vaccine efficacy **(Bonerba *et al.*, 2024).** In Egypt, similar lesions were observed in poultry flocks exposed to OTA-contaminated diets, underscoring the local importance of this toxin **(Al-Said & El-Tedawy, 2021).**

From a performance standpoint, AFs (especially aflatoxin B1) remain the most economically damaging due to their prevalence in maize-based poultry feed **(Mwenda, 2023).** In Egyptian farms, AF contamination has been linked with decreased egg production, poor eggshell quality, and stunted growth in broilers **(Mahmoud *et al.*, 2022; Al-Said & El-Tedawy, 2021).** These effects parallel findings from other African regions such as Nigeria and Cameroon, where feed contamination also results in productivity losses **(Akinmoladun *et al.*, 2025).**

Climate change further exacerbates the problem by shifting fungal ecology and extending the risk season for contamination. Warmer temperatures and fluctuating rainfall patterns in Egypt and North Africa are predicted to increase the prevalence of *Aspergillus flavus*, thereby elevating AFs risk **(Casu *et al.*, 2024).** This trend aligns with global reports that highlight the growing importance of climate-resilient management strategies in poultry feed safety.

Surveillance programs such as the dsm-firmenich World Mycotoxin Survey (2024) confirm that Egypt and the Middle East–North Africa (MENA) region consistently report high AFs contamination levels compared to Europe. These surveys provide evidence that Egyptian poultry production faces disproportionate challenges in ensuring feed safety, directly impacting flock health and market sustainability **(dsm-firmenich, 2024a, 2024b).**

Overall, the evidence demonstrates that mycotoxin exposure significantly compromises poultry health and productivity in Egypt, leading to impaired growth performance, organ pathology, immunosuppression, and increased mortality. Given the high reliance on maize and other cereal-based feed ingredients, alongside suboptimal storage practices, mycotoxin control in Egyptian poultry farms remains an urgent priority. Effective interventions—such as improved storage, regular feed testing, and the use of mycotoxin binders—are necessary to protect poultry health, enhance farm profitability, and safeguard food security **(Alam *et al.*, 2022).**

Mycotoxins and Meat Safety

Mycotoxins, produced mainly by Aspergillus, Penicillium, and Fusarium species, are a persistent food safety concern in both plant and animal-derived products. Their relevance extends to meat safety due to the bioaccumulation of these toxins in animal tissues, particularly when livestock are exposed to contaminated feed. In regions where monitoring and control systems are less stringent, including several African countries, the risk of dietary exposure through contaminated meat remains significant **(Awuchi *et al.*, 2022).**

The presence of mycotoxins in meat products is largely linked to indirect exposure, as animals ingest contaminated feed. Residues of aflatoxins (AFs), ochratoxin A (OTA), **fumonisins (FUM)**, and zearalenone have been detected in edible tissues, particularly liver and kidney, raising concerns about consumer health **(Alam *et al.*, 2022).** Such contamination poses challenges for food safety authorities, as conventional cooking and processing techniques do not fully eliminate mycotoxin residues.

A growing area of research also highlights the occurrence of mycotoxins in meat alternatives, particularly soy- and cereal-based analogues. **Mihalache *et al.* (2024)** reported that meat substitutes can serve as additional vectors of exposure, sometimes exceeding levels found in conventional meat due to the higher susceptibility of plant-based ingredients to fungal contamination. This broadens the scope of public health implications beyond animal products alone.

Toxicological Implications for Public Health

The toxicological impact of mycotoxins is well documented, including hepatotoxic, nephrotoxic, immunosuppressive, and carcinogenic effects. **Awuchi *et al.* (2022)** summarized that aflatoxins are potent hepatocarcinogens, OTA has nephrotoxic and carcinogenic potential, while **fumonisins (FUM)** are strongly associated with esophageal cancer. These risks are amplified in populations with high dietary exposure and limited healthcare infrastructure.

In the context of dietary transitions, **Mihalache *et al*., (2023)** demonstrated that replacing conventional meat with soy-based analogues could alter exposure patterns. While the intention is to improve sustainability and reduce health risks from red meat, the parallel increase in exposure to mycotoxins from plant-derived proteins raises a "hidden" food safety issue.

Meat Safety in Africa: Special Considerations

In African countries, particularly Egypt, climatic factors (hot and humid conditions) and storage practices increase the risk of fungal growth and mycotoxin production. Meat safety monitoring programs often face challenges in infrastructure and enforcement, allowing residues to enter the food chain undetected. According to **Alam *et al.* (2022),** developing regions remain more vulnerable due to inadequate screening systems and weak regulatory oversight. Consequently, consumers are at heightened risk of chronic health issues related to long-term low-dose exposure.

Mycotoxins represent a critical intersection of **animal feed safety, meat quality, and public health** (Platzer *et al*., 2025). They persist through the food chain and can accumulate in edible tissues, posing direct risks to consumers. Emerging concerns about their occurrence in meat alternatives further complicate dietary safety assessments. Effective mitigation requires an integrated approach—improving feed quality, enforcing residue monitoring, and strengthening awareness programs in high-risk regions such as Egypt and other African countries **(Alam *et al*., 2022).**

Mycotoxins and Meat Safety Challenges in Africa with a Focus on Egypt

In many African countries, the safety of meat is increasingly threatened by the silent infiltration of mycotoxins **(Adesola *et al*., 2024).** Hot and humid climates, coupled with limited infrastructure for storage and feed preservation, create ideal conditions for fungal growth and toxin production **(Nji *et al*., 2022).** Contaminated animal feeds remain the primary source of exposure, as livestock consume grains and by-products often inadequately dried or stored under poor hygienic conditions **(Narayanan *et al*., 2025).** This contamination leads to residues of toxins in edible tissues, reducing both the quality and safety of meat destined for human consumption **(Domingo *et al*., 2025).**

In Egypt, the problem is particularly relevant due to the heavy reliance on poultry, rabbits, and small ruminants as affordable protein sources **(Attia *et al*., 2025).** Mycotoxins compromise animal health by suppressing immunity, reducing growth performance, and predisposing animals to secondary infections. Consequently, the resulting meat is not only of inferior nutritional and technological quality but also presents a hidden chemical hazard to consumers **(Aboolo *et al*., 2025).**

Beyond direct tissue contamination, mycotoxins indirectly impact meat safety by accelerating spoilage, altering sensory characteristics, and decreasing shelf life **(Attia *et al*., 2025; Domingo *et al*., 2025).** In local markets where refrigeration and monitoring are inconsistent, these effects are amplified, leading to significant economic and health burdens **(Narayanan *et al*., 2025).** Moreover, the high per capita consumption of poultry in Egypt increases the likelihood of chronic dietary exposure to low doses of mycotoxins through meat and meat products **(Aboolo *et al*., 2025).**

The African and Egyptian contexts reveal a dual challenge: ensuring livestock productivity while protecting consumers from hidden toxicants **(Jalilzadeh-Amin *et al*., 2023).** Without targeted interventions in feed management, climate-adapted storage systems, and stronger food safety surveillance, mycotoxins will continue to undermine both public health and food security in the region **(Narayanan *et al*., 2025).**

Table (3). Key Impacts of Mycotoxins on Meat Safety and Quality in Africa (with a focus on Egypt)

Impact Area	Description	Specific Relevance to Egypt
Public Health Risks	Residues of aflatoxins, ochratoxin A, and fumonisins in edible tissues may cause chronic exposure, carcinogenic effects, and liver/kidney toxicity.	High poultry and rabbit meat consumption raises risk of cumulative exposure.
Meat Quality	Mycotoxins weaken animal immunity, leading to poor growth, higher fat deposition, and altered protein content, reducing the nutritional and technological value of meat.	Poultry meat often shows reduced tenderness and water-holding capacity in affected flocks.
Shelf Life & Safety	Contaminated animals are more prone to infections, leading to faster spoilage and reduced shelf stability.	Informal markets with limited refrigeration worsen spoilage risk.
Economic Losses	Reduced productivity, high mortality, increased veterinary costs, and meat downgrading due to poor quality or safety concerns.	Egypt faces significant economic pressure as poultry is the main affordable protein source.

Advances in Control, Mitigation, and Future Perspectives within a One Health Framework

The control of mycotoxin contamination in poultry production has undergone significant progress in recent years, driven by advances in feed technology, biotechnology, and integrated food safety management **(Liu *et al*., 2022; Tian *et al*., 2022).** Conventional strategies such as good agricultural practices, proper storage conditions, and feed additives (e.g., binders and adsorbents) remain essential for minimizing fungal growth and toxin accumulation **(Kihal *et al*., 2022).** However, these approaches alone are insufficient to address the complexity of multi-mycotoxin contamination and the emerging challenges linked to climate change and global trade **(Liu *et al*., 2022).**

Recent advances have focused on novel detoxification methods, including enzymatic degradation, microbial biotransformation, and nanotechnology-based adsorbents, which offer higher specificity and efficiency compared to traditional binders **(Ayub *et al*., 2025).** Plant-derived bioactive compounds and probiotics have also shown promise in mitigating the toxic effects of mycotoxins in poultry, improving gut health, immune responses, and overall resilience to toxin exposure **(Kumar *et al*., 2025).** Furthermore, predictive modeling and digital tools are increasingly being applied to forecast mycotoxin risks, allowing for more proactive risk management across the poultry value chain **(Strachan, 2023).**

Despite these advances, critical research gaps remain **(Maurya, 2025).** First, most detoxification strategies have been validated under controlled experimental conditions **(Mateo *et al*., 2025),** whereas field-level validation in diverse agro-ecological zones, particularly in Africa and the Middle East, is still limited **(Kihal *et al*., 2022; Rembold *et al*., 2023).** Second, limited data exist on the interactive effects of co-occurring mycotoxins and their potential to exacerbate toxicity **(Ayub *et al*., 2025; Maurya, 2025).** Third, consumer-focused research on the long-term risks of low-dose mycotoxin residues in meat and poultry products is underdeveloped, particularly in regions with high reliance on poultry protein **(Mateo *et al*., 2025).** Addressing these gaps requires interdisciplinary efforts that integrate veterinary sciences, public health, environmental monitoring, and socio-economic perspectives **(Chilenga *et al*., 2025).**

Adopting a One Health approach is crucial for ensuring sustainable poultry production and safeguarding public health **(Tian *et al*., 2022).** Mycotoxin contamination is not only an animal health issue but also a food safety and environmental problem that transcends sectoral boundaries **(Maurya, 2025).** Integrated monitoring systems linking farm-level surveillance, feed safety controls, and human health monitoring are needed to better understand exposure pathways and intervention points. Collaborative policies and investment in regional monitoring networks, particularly in Africa, can enhance resilience against mycotoxin-associated risks. Future research should emphasize eco-friendly mitigation technologies, scalable interventions for smallholder systems, and harmonization of regulatory frameworks across regions **(Chilenga *et al*., 2025).**

In summary, while notable progress has been achieved in developing novel control strategies, ensuring poultry productivity and food safety under a changing climate requires integrated, One Health-driven solutions. A paradigm shift from reactive to preventive approaches—grounded in innovation, collaboration, and sustainability—will be essential to mitigate the multifaceted risks of mycotoxins.

Conclusion

Mycotoxins and their producing fungi continue to pose profound challenges to poultry production, meat safety, and public health worldwide, with disproportionate impacts in Africa and Egypt due to climatic conditions, storage limitations, and restricted surveillance systems. The contamination of poultry feed with aflatoxins (AFs), ochratoxin A, fumonisins (FUM), and other toxins exerts multifaceted effects, ranging from impaired growth, immunosuppression, and increased disease susceptibility in birds to the deposition of residues in edible tissues, thereby compromising consumer safety. These residues carry carcinogenic, hepatotoxic, and nephrotoxic risks, while also threatening international trade and food security.

Recent advances in mitigation strategies—such as improved mycotoxin binders, enzymatic detoxification, nanotechnology-based adsorbents, and predictive modeling tools—demonstrate promising potential in reducing toxin bioavailability and safeguarding poultry health. Likewise, enhanced feed storage systems, rapid diagnostic platforms, and the integration of climate-smart agricultural practices represent critical progress in preventing fungal growth and toxin production. Yet, despite these achievements, significant gaps remain in regional surveillance, the harmonization of regulatory limits, and the adaptation of control measures to local contexts such as Egypt. In particular, the lack of comprehensive exposure assessments, insufficient farmer awareness, and limited infrastructure for continuous monitoring hinder the translation of global innovations into sustainable local practices.

From a One Health perspective, addressing mycotoxin contamination requires an integrative framework that links animal health, food safety, environmental sustainability, and human well-being. Poultry productivity and public health cannot be considered in isolation; rather, they are interconnected with agricultural practices, climate resilience, trade standards, and socioeconomic dynamics. Collaborative strategies that merge veterinary science, food safety policy, environmental monitoring, and consumer education are essential to mitigate risks effectively.

In conclusion, safeguarding poultry production and meat safety against mycotoxin contamination demands a shift from isolated interventions toward integrated, context-specific solutions. By aligning scientific innovation with regulatory enforcement, farmer training, and cross-sectoral collaboration, particularly under the One Health paradigm, it is possible to strengthen food safety, protect public health, and enhance the resilience of poultry industries in Egypt, Africa, and beyond.

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