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REVIEW ARTICLE

Evaluating the Impact of Fusariotoxins on Poultry Feed Safety

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Abstract

This study provides new insights into the prevalence and toxicological impacts of Fusariotoxins in poultry feeds, highlighting the urgent need for integrated management strategies to protect poultry health and improve food safety. These toxins negatively affect poultry by inhibiting growth and increasing their susceptibility to diseases. increased research efforts and enhanced agricultural practices are crucial for mitigating toxin levels in poultry feed. One significant aspect of poultry management and welfare practices is the prevalence of Fusarium species poultry feed. These species are commonly found and produce mycotoxins that pose significant risks to both poultry and human health. Fusarium fungi are well-known contaminants of agricultural commodities, particularly grains and poultry feeds, due to their hazardous mycotoxins, which threaten poultry health and food safety. The contamination of poultry feeds with Fusarium species and their mycotoxins represents a critical issue due to the detrimental effects on poultry health and productivity. Health challenges associated with mycotoxins produced by Fusarium species are of great concern. This survey compiles findings from various studies regarding the occurrence of Fusarium species in poultry feeds and the associated toxicological effects. The examination of Fusarium species in poultry feeds has garnered attention within the veterinary and agricultural sciences due to concerns about poultry health and food safety. As this survey will illustrate, there is a pressing need for microbiological, biochemical, and agricultural expertise within the veterinary science domain to understand and mitigate the impact of these fungi on poultry feeds.

1. Introduction

These mycotoxins contaminate feed used in poultry production, leading to serious health implications across different poultry species, affecting growth, feed efficiency, immune function, and overall marketability of poultry products (Weaver *et al.*, 2020; (Ghaemmaghami, 2024; Ghany *et al.*, 2021). Fusarium species are commonly isolated from poultry feeds, with studies indicating that they often co-occur with other fungal genera (Ghaemmaghami *et al.*, 2016). For instance, Greco *et al.* illustrate that mycotoxins produced by

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Fusarium are prevalent in poultry diets, emphasizing that 67.5% of tested feeds were contaminated with these fungi (Greco *et al.*, 2014). Moreover, Nwiyi *et al.* reported that Fusarium species contribute significantly to mycotoxin contamination, including harmful compounds like deoxynivalenol (DON), fumonisins, and zearalenone (Nwiyi *et al.*, 2019). This highlights the potential public health concerns linked to the consumption of affected poultry products. Fusarium species are largely recognized for their capacity to produce mycotoxins, which are toxic secondary metabolites that pose severe health risks to both livestock and, consequently, humans through the food chain (Krnjaja *et al.*, 2021). The contamination of animal feed by Fusarium species occurs due to various factors, including environmental conditions, agricultural practices, and storage methods, which create conducive conditions for fungal growth (Antonissen *et al*, 2014). Mycotoxin contamination of feed is a significant concern in the poultry industry, where these toxins can lead to a variety of health issues and economic losses. Chronic exposure to these mycotoxins from Fusarium can impair the immune response, reduce growth performance, and increase vulnerability to infectious diseases in birds (Girgis and Smith, 2010; (Awad *et al.*, 2013). The pervasive nature of Fusarium species within feedstuffs, particularly grains, underscores the need for vigilant monitoring and management practices to mitigate their impact (Omori *et al.*, 2019;). Fusarium species, especially those that produce mycotoxins such as deoxynivalenol, zearalenone, and fumonisins, are well-known for negatively affecting the health and productivity of poultry (Fig. 1). Fusarium species are known to produce a variety of mycotoxins, such as deoxynivalenol (DON), zearalenone (ZEN), and fumonisins, which can adversely affect the health and productivity of poultry (Fig. 2). This section maps on impact of fusarium species toxins on poultry health and productivity, including growth rates and disease susceptibility, and strategies to mitigate these toxins in poultry feeds through feed additives and agricultural practices. This comparative key research questions on growth performance, immune function, mitigation strategies, disease susceptibility, and agricultural contamination providing a comprehensive understanding to inform effective management practices.

2. Statement of Purpose

Fusariotoxins are secondary metabolites produced by toxigenic fungi of the genus Fusarium. The important and commonly encountered fusariotoxins are trichothecenes, fumonisins, and zearalenone. Research consistently shows that various animal feeds, including those for pigs, ruminants, and poultry, are susceptible to contamination by Fusarium species. Analyses of feeds indicate that Fusarium, alongside other fungal genera like Aspergillus and Penicillium, dominates the fungal contamination landscape in animal feedstuffs (Krnjaja *et al.*, 2021; Hamasalim *et al.*, 2021; Witaszak *et al.*, 2019). Notably, Fusarium species are linked to the production of mycotoxins such as deoxynivalenol (DON), zearalenone (ZEN), and fumonisins, which have been associated with various adverse health outcomes in livestock, including immunosuppression, reproductive failures, and feed refusal (Gherbawy *et al*, 2024); (Pietsch *et al*, 2013); (Dorn *et al*, 2011); (Zhang *et al*, 2018). Understanding the impact of Fusarium mycotoxins on livestock entails exploring their prevalence, effects on animal health, and strategies for mitigation.

Fig. 1. Fusariutoxins affecting the human health and animal.

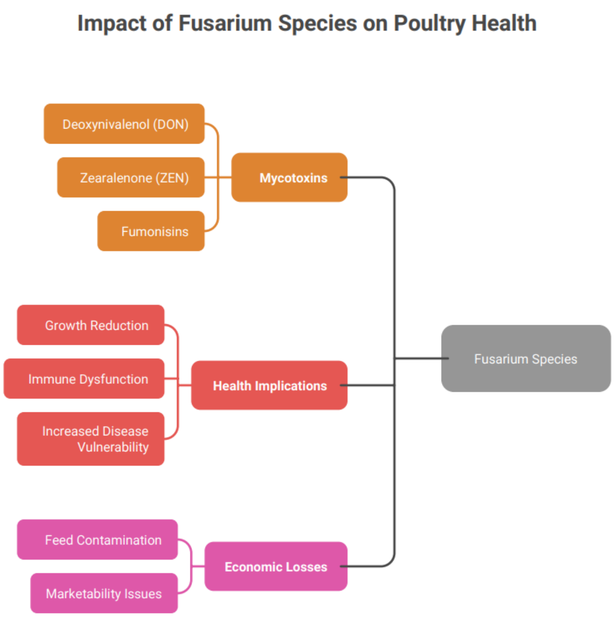

Fig. 2. Impact of fusarium species on poultry industry.

This response synthesizes the relevant literature to provide a detailed examination of the implications of Fusarium fungi in livestock feed. The mycotoxins produced by Fusarium, notably fumonisins and zearalenone, have been well-documented to impair animal health. Fumonisins, particularly those produced by Fusarium verticillioides and Fusarium proliferatum, are known to induce various pathological conditions in poultry (Deepthi *et al.*, 2017), Mansur *et al.*, 2014). Monge *et al.* found that a significant percentage of raw materials and poultry feeds contained notable amounts of these mycotoxins, with fumonisins frequently exceeding safety thresholds (Monge *et al.*, 2012). This potential for toxicity underlines the necessity for rigorous quality control in feed production. The impact of Fusarium contamination extends beyond health implications to include economic concerns for poultry producers. As stated by Gherbawy *et al.*, the frequent detection of Fusarium species in stored poultry feeds can lead to reduced feed quality and subsequently affect meat production (Gherbawy *et al.*, 2024). Additionally, Kulcsár *et al.* demonstrated that acute exposure to Fusarium mycotoxins could lead to oxidative stress and negatively affect liver metabolism in laying hens (Kulcsár *et al.*, 2021). This indicates a direct relationship between mycotoxin contamination and poultry welfare, potentially leading to compromised economic returns on poultry farming. In geographical studies, variations in the prevalence of Fusarium species in poultry feeds have been observed, reflecting local agricultural practices and environmental conditions. For example, in a survey conducted by Krnjaja *et al.*, Fusarium species were identified in over half of the investigated feeds in Serbia, with conditions conducive to fungal growth identified (Krnjaja *et al.*, 2011). Similarly, Oliveira *et al.* noted that in Brazil, Fusarium was one of the most frequently encountered genera in poultry feeds, confirming the widespread nature of these fungi (Gherbawy *et al.*, 2024).

3. Fusarium Species in Animal Feed

Research has shown that multiple Fusarium species are prevalent in different types of animal feed. For instance, a study revealed that Fusarium spp. constitutes up to 36.1% of the fungal population found in swine feed samples, emphasizing their significant presence in feeds for livestock (MM, 2018, Nowrozi, *et al.*, 2018). Other studies corroborate the widespread occurrence of Fusarium species in ruminant feeds and poultry diets, wherein Fusarium spp., along with Aspergillus spp. and Penicillium spp., emerged as the primary genera identified (Gherbawy *et al.*, 2024; Hamasalim *et al.*, 2021). Specifically, Hamasalim *et al.* noted the dominance of Fusarium species in various feed matrices, shedding light on their systemic prevalence across species and geographic regions (Witaszak *et al.*, 2019). Fusarium mycotoxins, such as deoxynivalenol (DON), zearalenone (ZEN), and fumonisins, are among the most concerning for livestock producers. These mycotoxins can exert a range of toxic effects on animals, including reduced growth rates, reproductive issues, and increased susceptibility to diseases (Fig. 2). For instance, studies have shown that broiler chickens fed diets contaminated with Fusarium mycotoxins exhibited suppressed immune functions, evidenced by decreased organ sizes such as the bursa of Fabricius, a key component of the immune system (Cheng *et al.*, 2018; Dolenšek *et al.*, 2021). Furthermore, the mycotoxin ZEN is known for its estrogenic effects, which can lead to reproductive dysfunctions in animals, particularly in pigs that are highly susceptible to its effects (Fig. 3) (Chang *et al.*, 2017; Antonissen *et al.*, 2014).

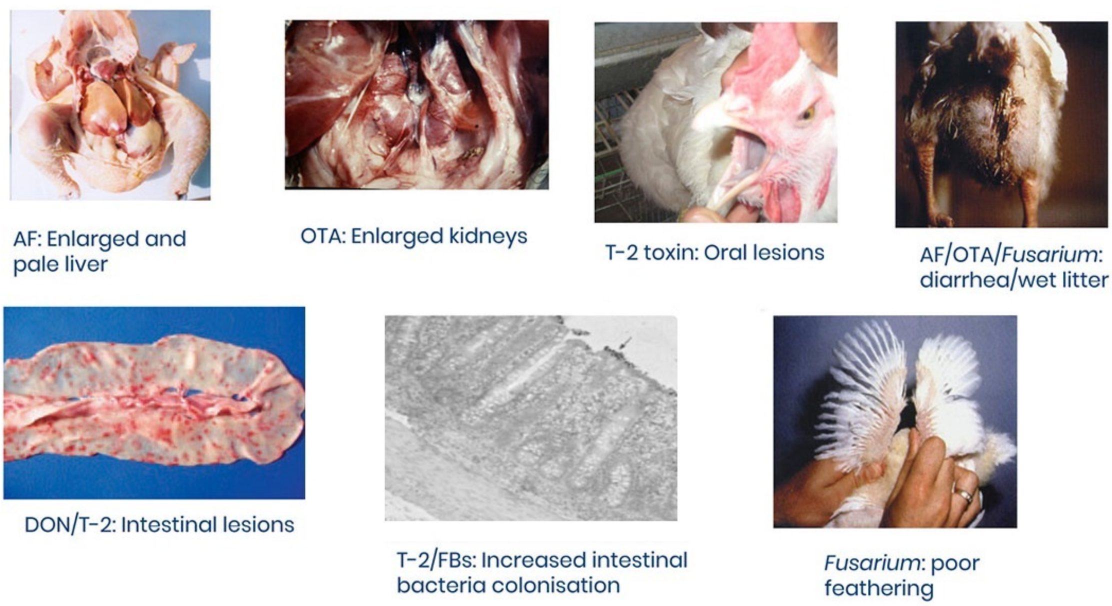

Fig. 3. Poultry health issues related to the mycotoxins produced by Fusarium species.

4. Consern by Fusarium

The dangers posed by these fungi are not limited to their mere presence; rather, they are associated with the production of mycotoxins, which can have devastating effects on animal health and productivity (Antonissen *et al.*, 2014). Mycotoxins, such as Deoxynivalenol (DON) and Zearalenone (ZEA), produced by Fusarium species, have been widely documented to impair reproductive performance, reduce feed intake, and induce toxic effects in various animal species (Pietsch *et al.*, 2013). For example, ZEA is an estrogenic mycotoxin linked to reproductive disorders in livestock, while DON is recognized for its effects in hampering feed consumption, often leading to what is termed "feed refusal" syndrome (Tan *et al.*, 2011). In a focused examination of ZEA, it was highlighted that its occurrence was significant across animal feeds, representing a critical area for further inspection and monitoring (Chang *et al.*, 2017). Reports indicate that Fusarium species are frequently encountered in crucial feed grains like maize and barley, which serve as staple components in livestock diets. The impact of climate change, particularly increasing humidity and temperature, could exacerbate Fusarium infections within grain crops, thereby elevating the risk of mycotoxin contamination in stored feeds (Stanciu *et al.*, 2015). Indeed, the intricate relationship between environmental conditions and Fusarium prevalence is underscored by findings that highlight how improper storage and handling practices increase susceptibility to fungal infestations (Jaimez *et al.*, 2004). The mechanism by which Fusarium mycotoxins exert their detrimental effects is multifaceted. Mycotoxins such as DON and ZEN primarily affect the gastrointestinal health of poultry, disrupting nutrient absorption and leading to inflammatory responses (Awad *et al.*, 2013). These toxins can lead to a range of clinical manifestations including decreased feed intake, poor weight gain, and ultimately, economic losses for producers (Wasan *et al.*, 2022; Antonissen *et al.*, 2014). The immunotoxic effects of these compounds exacerbate issues, rendering poultry more susceptible to secondary infections like necrotic enteritis and coccidiosis, thereby compounding health challenges within flocks (Girish and Smith, 2008; Antonissen *et al.*, 2014). Moreover, Fusarium-contaminated feeds can influence the metabolic processes in poultry, leading not only to physical health issues but also to altered behavioral responses due to discomfort or illness. When exposed to contaminated feed, birds often show signs of reduced activity and increased stress levels, further compromising their overall welfare and productivity (Girgis and Smith, 2010; Wingfield *et al.*, 2021) This stress response is critical as it can lead to decreased egg production in layers and lower growth rates in broilers, ultimately resulting in substantial economic repercussions across the poultry industry (Onajobı *et al.*, 2023).

The impact of Fusarium mycotoxins on livestock health is profound and multifaceted. In particular, zearalenone is known to cause estrogenic effects, leading to reproductive issues in animals, while fumonisins have been linked to neurotoxicity and carcinogenic effects (Zhang *et al.*, 2018; ENI *et al.*, 2018; Chang *et al.*, 2017). Additionally, chronic exposure to lower levels of these mycotoxins can lead to cumulative effects, ultimately compromising animal health and productivity (Aguín *et al.*, 2013; Wu *et al.*, 2025). Studies of dietary impact have demonstrated that even moderate levels of fusariotoxins can disrupt growth and immunity in various animal species, emphasizing the imperative for stringent control measures in feed production (Wagacha *et al.*, 2010). Young broiler chickens are particularly sensitive to Fusarium mycotoxins, which can result in poor intestinal health and compromised immune function. Research has shown that exposure to chronic levels of feed contaminated with these mycotoxins can lead to reduced height of intestinal villi, impacting nutrient absorption and overall health (Weaver *et al.*, 2020; Fraeyman *et al.*, 2018). It is also established that contaminated feed correlates with an increase in gastrointestinal infections, further exacerbating health issues in young poultry (Weaver *et al.*, 2020; (Ghaemmaghami *et al.*, 2018). Furthermore, the consumption of mycotoxin-laden feed is linked to adverse performance outcomes, including reduced weight gain and poor feed conversion ratios in affected birds, significantly hampering economic viability for poultry producers (Nwiyi *et al.*, 2019; Gherbawy *et al.*, 2024; Alders *et al.*, 2018). In addition to acute effects, chronic exposure to Fusarium mycotoxins can lead to long-term health issues. The combined effects of ZEN and other trichothecenes have synergistic impacts on poultry, exacerbating immune suppression and further increasing susceptibility to infectious diseases (Wu *et al.*, 2021; (Ghaemmaghami *et al.*, 2018; Liu & Applegate, 2020). Research indicates that prolonged exposure to subclinical levels of mycotoxins can impair growth performance and immunological responses, potentially leading to increased mortality rates in affected populations (Danbappa *et al.*, 2018; Meena *et al.*, 2020; Polák and Paszczyk, 2021). Therefore, understanding the mechanisms of Fusarium toxicity is critical for developing effective prevention and intervention strategies within the poultry industry. Moreover, mycotoxin interactions with other microbial infections present further challenges. For example, the coccidiosis caused by Eimeria species can be aggravated by the immunosuppressive effects of Fusarium toxins, leading to compounded economic losses within the poultry sector (Gómez-Osorio *et al.*, 2024; Yang *et al.*, 2019). Addressing mycotoxin contamination should involve multi-faceted approaches integrating nutrition, management practices, and biosecurity measures aimed at reducing pathogen load and alleviating stressors on poultry (El-Sharkawy *et al.*, 2023).

5. Methods for Assessing the Prevalence of Fusarium

Analytically, numerous methods for assessing the prevalence of Fusarium and their mycotoxins in animal feed have been employed, ranging from traditional microbiological culturing techniques to advanced molecular diagnostics. For instance, the use of real-time PCR has emerged as a powerful tool to detect and quantify specific mycotoxin-producing Fusarium strains within feed samples, thereby enhancing the ability to monitor and manage these contaminants effectively (Sohlberg *et al.*, 2022). Moreover, there is a growing emphasis on the need for consistent monitoring practices and regulatory frameworks to oversee mycotoxin levels in animal feeds, particularly in regions where agricultural practices may enable high contamination rates (Latham *et al.*, 2023). In response to these challenges, various strategies have been proposed to mitigate the impact of Fusarium and their mycotoxins on animal feeds. Among these are biocontrol measures, such as the employment of specific microbial strains that can reduce fungal biomass and the associated toxin production in contaminated feeds (Valiullin *et al.*, 2023). Moreover, developing robust pre- and post-harvest strategies can aid in minimizing Fusarium infection rates, including implementing crop rotation practices and using resistant plant varieties (Simões *et al.*, 2023). The environmental conditions under which feeds are stored and processed significantly influence the likelihood of Fusarium contamination. High moisture content and fluctuating temperature conditions are particularly conducive to the growth of Fusarium species and subsequent mycotoxin production (Tan *et al.*, 2011; Pietsch *et al.*, 2013). Studies show clear correlations between poor storage conditions and increased levels of mycotoxins in animal feeds, suggesting that improving storage practices could mitigate these risks (Deepthi *et al.*, 2017; Herkert *et al.*, 2019; Krnjaja *et al.*, 2011). Furthermore, specific agricultural practices, such as the use of susceptible crop varieties or inadequate crop rotation, can exacerbate the prevalence of Fusarium infections in feed crops, thus elevating the risk of contamination in the feed supply chain (Pfordt *et al.*, 2020; Dolenšek *et al.*, 2021). Fusarium species, such as *F. graminearum* and *F. culmorum*, are well documented for their mycotoxin production capabilities. Their prevalence in grains used for animal feed highlights the necessity for regular monitoring and assessment strategies to ensure feed safety (Wang *et al.*, 2022; Dorn *et al.*, 2011; Krnjaja *et al.*, 2011). Research also indicates that animal feed containing higher levels of contaminated cereals potentially harbors mycotoxins exceeding permissible limits set by health authorities, thereby increasing the risk of mycotoxicosis in affected animals (Noman, 2022; Chang *et al.*, 2017). For example, zearalenone and fumonisins have been observed at concerning concentrations in commercial pet food and fish feed, illuminating the widespread nature of Fusarium contamination (Gherbawy *et al.*, 2024; Pietsch *et al.*, 2013).

A critical aspect of managing Fusarium contamination involves the implementation of effective mitigation strategies in feed processing and storage. These may include the use of mycotoxin-binding agents and probiotics that can reduce the bioavailability of mycotoxins, thus mitigating their harmful effects on animal health (Hussein & Saadullah, 2023; Gkiorsos *et al.*, 2022; Ostrý *et al.*, 2010). Advances in molecular biology and biochemistry have facilitated the development of detection methods that allow for the rapid identification of toxigenic Fusarium species and their associated mycotoxins in feed samples (Villafana *et al.*, 2019; Brown *et al.*, 2012). Such methodologies are essential for the proactive management of feed safety risks related to Fusarium contamination (Fig. 4)

Fig. 4. Management of poultry feed safety risks related to fusariotoxins.

6. Economic Consequences of Fusarium

The economic repercussions of Fusarium contamination are also noteworthy. The financial costs associated with degraded animal health and productivity directly correlate to mycotoxin levels present in feeds, ultimately translating into reduced economic returns for livestock producers (Antonissen *et al.*, 2014). It is estimated that over 2% of grains harvested each year may become economically unviable due to severe contamination with mycotoxins, underscoring the need for proactive measures in agricultural management (Wu *et al.*, 2021). Furthermore, regular surveillance and public health initiatives focused on monitoring mycotoxin levels in animal feeds are essential for ensuring food safety and protecting human health (Latham *et al.*, 2023). A thorough understanding of the epidemiology of Fusarium species across agricultural settings can illuminate the complex interactions between fungi, the products involved in animal feed, and their broader ecological implications. Continuing advances in genomic technologies and phylogenetics are pivotal for providing deeper insights into the pathogenicity and diversity of Fusarium species (Mitterbauer *et al.*, 2003), which could enable more targeted management practices in animal nutrition and health. The presence of mycotoxins such as fumonisins and ZEN can also interfere with endocrine function in poultry (Al-Gabr *et al.*, 2018). Zearalenone, in particular, acts as a nonsteroidal estrogenic compound, which can disrupt reproductive processes and lead to significant implications for egg production and hatching rates (Al-Gabr *et al.*, 2018) Purnamasari & Purnomo, 2022). Such hormonal disruptions could foster increased infertility and developmental problems in offspring, thereby affecting future production capacities of poultry flocks (Al-Gabr *et al.*, 2018).

In addition to health implications for livestock, the economic burden of Fusarium mycotoxin contamination is significant. Losses occur both from reduced feed quality and the potential for decreased animal performance (Tardieu *et al.*, 2019; Stanciu *et al.*, 2015). This reality underscores the importance of not only preventive measures at the agricultural level but also regulatory oversight ensuring that feed products meet safety standards for mycotoxin levels (Hudu *et al.*, 2024). Research continues to evolve, with emphasis placed on understanding the complex interactions between environmental factors and the pathogenicity of Fusarium species, which will assist in developing improved strategies for managing mycotoxin risks in animal feeds (Sadiq *et al.*, 2019; Watanabe *et al.*, 2011; Simões *et al.*, 2022). The economic ramifications tied to Fusarium mycotoxins in livestock are considerable. The direct health impacts on livestock can lead to decreased feed efficiency and growth rates, which, in turn, can have far-reaching consequences for production systems. Losses attributed to poor livestock growth, veterinary expenses for untreated illnesses, and reduced reproductive success can accumulate swiftly into significant economic burdens for livestock producers (Griessler *et al.*, 2010; Vandicke *et al.*, 2021; Bryła *et al.*, 2022). For instance, the co-occurrence of mycotoxins, where different toxins are present simultaneously in feed, can compound these effects, further challenging the maintenance of livestock health (Fig. 5) (Stanciu *et al.*, 2015).

7. Methods for Reducing Fusarium

To address the challenges posed by Fusarium mycotoxins, several mitigation strategies are recommended. These include stringent feed management practices that involve proper storage conditions to prevent mold growth, the inclusion of mycotoxin binders in feed formulations, and regular monitoring of feed for contamination (Wingfield *et al.*, 2021; Nwiyi *et al.*, 2019).

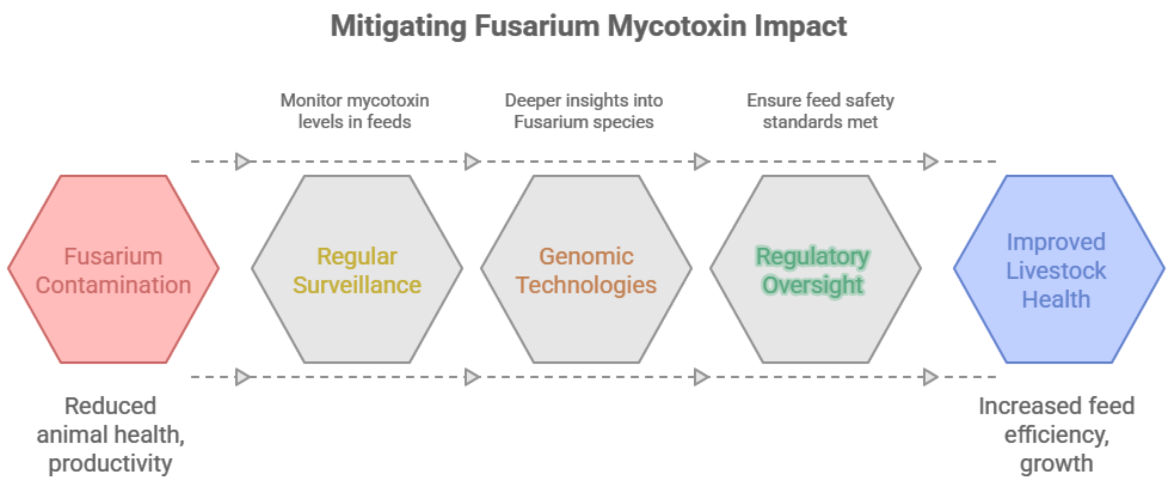

Fig. 5. Diagrams for mitigating fusariotoxins.

Additionally, the introduction of probiotics and other dietary supplements is being explored as a means to bolster immune responses and mitigate the adverse effects of mycotoxin exposure (Yang *et al.*, 2019; Ahmad *et al.*, 2022). These strategies are essential to reducing the prevalence of mycotoxin exposure and preserving both poultry health and economic viability. The mitigation of Fusarium contamination in poultry feeds is imperative. Recent studies exploring the effects of treatments, such as gamma irradiation, have shown promise in reducing mycotoxin levels, thereby improving feed safety (Deepthi *et al.*, 2017). Understanding the dynamics of Fusarium contamination can aid in developing effective feed management strategies, which may include rigorous monitoring, genetic selection of feed crops resistant to pathogen colonization, and the application of mycotoxin binders or inhibitors to negate the harmful effects of mycotoxins. The impact of Fusarium mycotoxins extends beyond immediate health risks, linking to broader concerns over food safety and public health. Continuous research efforts are necessary to elucidate the long-term implications of low-level mycotoxin exposure within animal populations, providing a comprehensive understanding of potential carryover effects into the human food chain. The occurrence of Fusarium mycotoxins necessitates a robust and multi-faceted approach to address both the immediate and long-term challenges posed to livestock health and productivity. By integrating good agricultural practices, vigilant feed monitoring, and innovative mitigation strategies, stakeholders in the agriculture sector can better manage the risks associated with Fusarium contamination in livestock feed (Fig. 6).

Fig. 6. Control of fusariotoxin strategies in poultry feed.

Regulatory entities worldwide recognize the relevance of Fusarium and strive to create frameworks for monitoring and managing mycotoxin levels in the food and feed supply chains. Various nations have implemented guidelines for acceptable limits of specific mycotoxins, including zearalenone and fumonisins, acknowledging their detrimental effects on both human and animal health (Valiullin *et al.*, 2023; Greeff-Laubscher *et al.*, 2019; Salem *et al.*, 2015). This highlights the global challenge of securing safe agricultural products in light of environmental conditions favorable to fungus propagation and toxin production. The process by which Fusarium mycotoxins contaminate livestock feed begins in the field, where environmental conditions such as high humidity and improper storage practices facilitate fungal growth and subsequent toxin production. For example, the presence of Fusarium species has been recorded in various forage types, indicating a potential risk as these samples are frequently used as livestock feed (Krnjaja *et al.*, 2021; Ekwomadu *et al.*, 2021). Factors influencing mycotoxin accumulation include agricultural practices, such as crop rotation and the use of resistant plant cultivars, although challenges persist due to environmental variability (Wegulo, 2012; Tola and Kebede, 2016). Consequently, the contamination of livestock feed with Fusarium mycotoxins is not only a direct result of fungal presence but is exacerbated by inadequate management and storage conditions. To mitigate the health risks associated with Fusarium mycotoxin contamination, various strategies have been proposed. Some include the implementation of effective feed processing techniques, the use of mycotoxin adsorbents in animal diets, and the dietary inclusion of natural feed additives (Kulcsár *et al.*, 2021; Salazar *et al.*, 2020; Latham *et al.*, 2023). Recent advancements highlight the role of certain microorganisms and enzymes in degrading mycotoxins, thus providing a biological avenue for detoxifying contaminated feed materials (Gari, 2024; Zhao *et al.*, 2023). Furthermore, strict monitoring and adherence to established regulatory limits for mycotoxin concentrations in animal feed can help limit exposure and the associated risks to both livestock and human consumers of animal products (Jensen *et al.*, 2019; Deepthi *et al.*, 2017; Brodal *et al.*, 2020). In addition to interventions at the feed level, it is critical to bolster research into genetic approaches and breeding programs to develop crops that are resistant to Fusarium infections (Wegulo, 2012; Tola & Kebede, 2016). Such advances could minimize initial contamination rates at the source, which remain pivotal in ensuring the safety and quality of animal feed. Fusarium species are prolific in various environments, particularly under incorrect storage conditions, which fosters their growth and toxin production (Onajobı *et al.*, 2023; (El-Sharkawy *et al.*, 2023). The presence of Fusarium species in feed signals not only contamination but also poses risks for public health authorities due to potential residues in animal products (El-Sharkawy *et al.*, 2023). To mitigate these risks, appropriate management strategies must be employed, such as regular monitoring of feed for mycotoxin levels and the implementation of feed additives that can bind mycotoxins (Weaver *et al.*, 2020; Ghany *et al.*, 2021). Probiotics and yeast products have also been suggested as helpful adjuncts in dietary formulations, as they can enhance gut health and reduce the negative impacts of mycotoxin ingestion by promoting a healthier gut microbiome (Wingfield *et al.*, 2021).

8. Future Research

Given the inherent complexity in the interaction between Fusarium species and animal feeds, future research must prioritize integrative approaches that encompass agricultural science, animal health, and food safety. Collaborative efforts across fields can lead to enhanced methodologies for the detection, prevention, and remediation of Fusarium mycotoxin contamination, thereby safeguarding both animal welfare and public health outcomes. Ultimately, the persistence of Fusarium species in animal feeds accentuates an ongoing challenge that necessitates a comprehensive understanding of fungal biology, agricultural practices, and the implications of mycotoxin exposure on health and food safety systems. This understanding can inform evidence-based policies and management practices aimed at reducing the prevalence of these mycotoxins in food production systems globally, thus ensuring sustainable agricultural practices and enhancing animal and human health. Research has also highlighted the importance of storage conditions in preventing mycotoxin production (Onajob1 *et al.*, 2023; Hof, 2020). Implementing biosecurity measures and decreasing the microbial load in poultry houses can significantly reduce the scavenging opportunities for Fusarium spp. These fungi thrive in warm, moist conditions that are typical in poorly ventilated poultry housing, thus focusing on improved airflow and moisture control can be beneficial (Sokolovic *et al.*, 2022; Grace *et al.*, 2024). Hence, addressing these environmental factors must be part of an integrated response to reducing the adverse impacts of Fusarium on poultry health.

Current research underscores the necessity for systematic assessment of mycotoxin levels in relation to poultry feed production, storage, and feeding practices. This can include routine microbiological evaluations to detect Fusarium species and assess mycotoxin levels, thus enabling proactive management to ensure poultry wellbeing and reduce the risk of economic loss due to health-related performance declines (Omori *et al.*, 2019; Krnjaja *et al.*, 2019; Cooper *et al.*, 2025). Regulatory standards for permissible mycotoxin levels in feed should be strictly enforced to minimize poultry exposure and subsequent health complications (Sohail, 2020).

9. Conclusion

In conclusion, Fusarium significantly impacts poultry health primarily through the production of harmful mycotoxins. The implications of mycotoxin exposure necessitate comprehensive monitoring and management strategies that incorporate nutritional interventions and improved biosecurity practices to safeguard poultry health and productivity. Collectively, these efforts not only promote the welfare of poultry but also serve to protect public health by ensuring the safety of poultry-derived products. The ongoing survey of Fusarium species in animal feeds reveals their widespread presence and significant role in agricultural systems. Efforts to characterize Fusarium's impact on feed quality, animal health, and economic viability continue to be paramount as we seek innovative solutions to mitigate the challenges posed by these mycotoxins. Understanding the interactions between Fusarium species, environmental conditions, and agricultural practices will be critical for improving animal feed safety and health outcomes moving forward. Also, the health of poultry is significantly impacted by Fusarium species through the production of various mycotoxins. The multifaceted effects of these contaminants not only hinder growth and productivity but also compromise the immune systems of affected birds, increasing their susceptibility to infections. Acknowledging and addressing these challenges through improved management practices and further research into mitigation strategies is essential for sustainable poultry production. Continued vigilance and innovation are required to safeguard poultry health against the ever-present risks posed by Fusarium mycotoxins.

And finally, it can be stated that the presence of Fusarium species and their mycotoxins in poultry feeds poses a multifaceted threat to poultry health, productivity, and safety. Continuous surveillance and improved agricultural practices are vital in addressing this issue, as are advancements in feed processing technologies aimed at reducing mycotoxin prevalence. Also, employing experts in the field of animal feed hygiene can greatly assist the producer in this regard.

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