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Impact of Ochratoxin Contamination on the Growth and Development of Broiler Birds Amidst the Global Food Crisis

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***Abstract* - Ochratoxins are toxic secondary metabolites produced by Aspergillus and Penicillium fungi, often contaminating staple grains such as corn, wheat, and barley. These toxins pose significant health risks through dietary exposure. This study aimed to assess the effects of ochratoxins on the growth and development of broiler chickens, especially in the context of the ongoing global food crisis. We evaluated key growth parameters, including body weight, feed intake, feed conversion ratio, and mortality rate, using 30-day-old chicks separated into three (3) different groups including the control. The chicks were administered feeds contaminated with ochratoxins at concentrations of 0 ml, 0.6 ml, and 1.2 ml. Our analysis showed that as the concentration of ochratoxins increased, there was a notable decrease in weight gain and feed intake, accompanied by a deterioration in the feed conversion ratio and an increase in mortality rate. Specifically, significant variations ($p<0.05$) were observed across all parameters, with the highest concentrations of ochratoxins (0.6 ml and 1.2 ml) leading to adverse effects on the growth performance of the broiler birds. Mortality rates were recorded at treatment levels of 0.6 ml and 1.2 ml, highlighting the detrimental impact of higher ochratoxin levels on broiler health and productivity.**

Keywords: Ochratoxins, concentration, growth, broiler birds, global food crisis, health impacts.

I. INTRODUCTION

In the face of an escalating global food crisis, characterized by supply chain disruptions, climate change, and increasing demand for protein sources, the poultry industry stands at a crucial juncture. Broiler chickens, as a primary source of affordable and nutritious meat, play an essential role in meeting the protein needs of a growing global population (Ekpo *et al.*, 2019). However, the efficiency and productivity of broiler poultry systems are increasingly threatened by various challenges, including mycotoxin contamination. Among these, ochratoxin A (OTA) poses a significant and underappreciated risk. Produced by the fungi Aspergillus ochraceus and Penicillium verrucosum, OTA contaminates feed and foodstuffs, leading to severe repercussions for poultry health and productivity. Ochratoxin A (OTA) is a potent mycotoxin produced by fungi of the Aspergillus and Penicillium genera, notably Aspergillus ochraceus and Penicillium verrucosum. It is commonly found in a variety of agricultural products, including cereals, coffee, and dried fruit, and poses significant risks to both human and animal health (Njobeh *et al.*, 2015). In poultry, OTA contamination in feed has emerged as a critical concern due to its adverse effects on growth performance and overall health.

OTA is known for its nephrotoxic properties, affecting the kidneys and other organs, which can result in severe metabolic disturbances in poultry (Feng *et al.*, 2016). The toxin can impair kidney function, leading to reduced growth rates and feed efficiency in broilers. Studies have shown that OTA can induce oxidative stress and damage to the renal tissue, contributing to decreased weight gain and feed conversion ratios (Tuzun *et al.*, 2019). This is particularly problematic in the context of commercial poultry farming, where maximizing growth performance and feed efficiency is crucial for economic viability.

The global food crisis has further compounded the issue of OTA contamination. With increasing demand for poultry products and limited resources for effective feed management, the presence of OTA in feed poses a serious challenge to food security and animal welfare (Wu *et al.*, 2021). The effects of OTA on broilers are compounded by the potential for reduced feed intake and inefficient feed conversion, which can exacerbate the impacts of the global food crisis by increasing production costs and decreasing overall yield (Boudra *et al.*, 2022).

Several studies have explored the impact of OTA on poultry health, revealing a range of negative effects. For instance, OTA has been shown to adversely affect immune function, increasing susceptibility to other infections and diseases (Liao *et al.*, 2020). Additionally, OTA contamination has been linked to liver damage and other systemic health issues, which further compromise the overall well-being and productivity of broiler birds (Hao *et al.*, 2018).

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The reduction in feed efficiency and growth performance due to OTA contamination can also have cascading effects on poultry production systems. For instance, decreased growth rates and increased feed conversion ratios can lead to higher feed costs per unit of weight gain, impacting the financial sustainability of poultry operations (Mousavi *et al.,* 2017). Therefore, understanding the full scope of OTA's impact on broiler health and performance is essential for developing effective mitigation strategies. In light of these challenges, it is imperative to investigate the impact of OTA on broiler growth and development in more detail. This research aims to elucidate the extent of OTA's effects on weight gain, feed intake, and feed conversion efficiency in broiler birds. By addressing these issues, the study seeks to contribute to more effective management strategies for reducing OTA contamination and improving poultry health and production outcomes.

Ochratoxin A is a potent mycotoxin with well-documented nephrotoxic, hepatotoxic, and immunosuppressive properties. It frequently contaminates grains and other feed components, resulting in a pervasive issue for livestock industries globally. As the world grapples with food security challenges, understanding the impact of OTA on broiler chickens becomes crucial. This introduction delves into the implications of OTA contamination on broiler growth and development within the context of the global food crisis, underscoring the urgent need for effective mitigation strategies.

Ochratoxin A is a persistent and widespread contaminant, naturally occurring mycotoxin that poses serious health risks to both humans and animals (Ubi *et al.,* 2022). It is produced by certain species of the fungi Aspergillus and Penicillium, which commonly infest cereal grains, feed ingredients, and other agricultural products (Samaržija *et al.,* 2017). OTA is notorious for its stability and persistence under various environmental conditions, which facilitates its widespread occurrence in agricultural commodities.

For broiler chickens, OTA contamination in feed presents a significant threat. The toxin accumulates in the kidneys, liver, and other tissues, leading to a spectrum of adverse health effects. These include reduced growth rates, impaired feed conversion efficiency, and increased susceptibility to diseases (Sweeney & Dobson, 1998). The impact on poultry health is not only a welfare concern but also affects productivity and economic viability, highlighting the critical need for effective management strategies.

Impact on Growth and Development

The growth and development of broiler birds are closely linked to their nutritional intake and overall health. OTA contamination disrupts this balance by impairing nutrient absorption and utilization. Studies have shown that OTA exposure can lead to significant reductions in weight gain, feed intake, and overall feed conversion efficiency (Masoero *et al.,* 2012). These effects are particularly concerning in the context of the global food crisis, where optimizing feed efficiency is essential for maximizing poultry production and ensuring food security.

In broiler chickens, even low levels of OTA contamination can have detrimental effects on growth parameters. Research indicates that OTA can cause stunted growth and lower body weights, with more severe consequences observed at higher contamination levels. The toxin's impact on feed efficiency and growth underscores the broader implications for poultry production, including increased feed costs and reduced profitability (Samaržija *et al.,* 2017).

Economic and Health Implications

The economic implications of OTA contamination are extensive. Direct losses include decreased productivity and increased feed costs, as contaminated feed may need to be discarded or treated to mitigate OTA levels. Indirect losses involve higher veterinary expenses and potential reductions in the market value of affected birds. Moreover, the potential for OTA accumulation in poultry products raises concerns about food safety, with possible health risks for consumers (Sweeney & Dobson, 1998). This situation exacerbates market instability and adds pressure to already strained food supply chains, making the management of OTA contamination a critical issue for the poultry industry.

Addressing the Challenge

Mitigating the impact of ochratoxin contamination requires a comprehensive approach. Strategies include regular monitoring of feed ingredients and environmental conditions, employing feed additives to neutralize or reduce OTA levels, and implementing rigorous quality control measures in feed production (Masoero *et al.,* 2012). Advances in biotechnology and mycotoxin deactivation technologies offer promising solutions for reducing OTA contamination and its effects on poultry health.

Furthermore, collaboration between researchers, policymakers, and industry stakeholders is essential for developing and enforcing regulatory standards to limit ochratoxin levels in feed. Public awareness and education about the risks associated with ochratoxin contamination are also crucial for promoting safer feed practices and improving overall poultry health.

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Ochratoxin contamination represents a significant threat to the growth and development of broiler birds, with far-reaching implications for global food security. As the world faces an increasingly severe food crisis, addressing the impact of mycotoxins like ochratoxin A is vital for sustaining poultry production and ensuring a stable food supply. By adopting effective management strategies and fostering collaborative efforts, the poultry industry can mitigate the adverse effects of ochratoxin contamination and contribute to a more resilient and secure global food system.

Investigating the impact of ochratoxin A (OTA) contamination on broiler birds amidst the global food crisis is rooted in its significant implications for poultry health, economic stability, and food security. OTA, a mycotoxin produced by Aspergillus and Penicillium species, poses serious risks to broiler health by impairing kidney function, reducing growth rates, and compromising feed efficiency (Sweeney & Dobson, 1998). These health impacts are particularly critical in a global context where maximizing poultry production is essential to meet the protein demands of a growing population.

OTA contamination directly affects the growth and productivity of broiler chickens. Research has shown that even low levels of OTA can lead to stunted growth, reduced feed intake, and lower feed conversion efficiency (Masoero *et al.*, 2012). In a time when the poultry industry is under pressure to increase output efficiently, these effects translate into significant economic losses. Reduced productivity not only impacts the profitability of poultry operations but also exacerbates food supply challenges, as lower production rates can lead to increased feed costs and higher prices for consumers.

The broader economic implications of OTA contamination are substantial. The need to discard or treat contaminated feed, along with potential veterinary costs and reduced market value of affected birds, adds financial strain to poultry producers (Samaržija *et al.*, 2017). Moreover, OTA's potential accumulation in poultry products raises food safety concerns, impacting consumer health and market stability.

Addressing OTA contamination is thus crucial for maintaining the health and productivity of broiler birds, ensuring economic viability for poultry producers, and safeguarding global food security. Effective management and mitigation strategies are essential to counteract these adverse effects and enhance the resilience of the poultry industry amidst the global food crisis.

II. Aim and Objectives

The primary aim of this study is to investigate the impact of ochratoxin A (OTA) contamination on the growth and development of broiler birds in the context of the global food crisis. This research seeks to elucidate how OTA affects broiler health, productivity, and economic viability, and to identify effective management strategies to mitigate these impacts.

Objectives

1) To determine the effect of ochratoxin contamination on key growth parameters of broiler birds.
2) To assess the Impact of OTA on Broiler Health as well as the survival rate.
3) To determine the extent of ochratoxins effects on the experimental birds.

III. Materials and Methodology

Study Site

The study was carried out at the Department of Genetics and Biotechnology Animal House isolation of fungi and ochratoxin extraction was carried out in the Department of Microbiology Laboratory, Faculty of Biological Sciences. The facility is equipped with controlled environmental conditions, including temperature, humidity, and ventilation, ensuring optimal settings for poultry research. The Animal House provides a suitable environment for maintaining broiler birds and conducting controlled experiments.

Materials for Ochratoxin isolation

Mycotoxin was isolated from already purchased poultry feed sample. Other materials used for the study are; potato dextrose agar, saline solution, chloroform, sodium bicarbonate, solution, ethyl acetate formic acid, toluene 1%P-dimethyl aminobenaldehyde. Petri dishes, incubator, microscope, pH scale, conical flask, Whatmann No1 filter paper, water bath, Evaporator, silica gel, thin layer chromatographic plates.

Materials

1) Broiler Chickens: A total of thirty (30) birds was purchased from Nkechi farm at Akim, Calabar Municipality, Cross River State, Nigeria.
2) Feed: Commercial starter and finisher mash feed of 0-1Week of storage time was purchased from a reputable commercial feed seller at Akim, Calabar Municipality, Cross River State.
3) Data Analysis Software: For statistical analysis of growth and health data.

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Methods

Identification and Isolation of Ochratoxin

2kg of Commercial feed sample was measured, moistened and incubated at 28^{o}C for 7 days to promote fungi growth in feed (Robens and Richard, 1992).

Isolation of mycotoxin: Potato dextrose agar plate was prepared and the collected poultry feed sample was serially diluted in saline. The samples were inoculated into agar plates. The plates were incubated at 28^{o} C for 5 days. After incubation, the total number of fungal population per gram of feed was estimated by plate count using microscope and fungal species was identified.

Characterization and identification of fungi: Suspected colonies were collected and emulsified in lactophenol cotton blue and observed under microscopic examination, and then each colony was inoculated into potato dextrose agar separately to obtain isolated culture. Based on morphological and cultural characterization (as Ochratoxin producing fungi appeared greenish) the fungi isolates was identified.

Mass production of Penicillium / Ochratoxin: The potato dextrose broth was then prepared to culture the fungi for Ochratoxin production. The pH was adjusted to 6.0 and the medium distributed in a 2L conical flask and sterilized at 121^{o}C, 6.804kg pressure for 15min. The flask was cooled and then inoculated with spore suspension of Penicillium and incubated at 28^{o}C for 2 Weeks.

Extraction of Ochratoxin: After 2 Weeks the mycelia was removed from the medium and the liquid culture was filtered through Whatmann No.1 filter paper. The cultured filtrate was concentrated under reduced pressure in an evaporator in a water bath. The concentrated culture filtrate was shaken repeatedly with 100ml volume of chloroform and the extraction repeated 3 times.

The chloroform extract was combined and filtered through Whatman No.1 filter paper. From the filtered chloroform the toxin was extracted with sodium bicarbonate solution by shaking the chloroforms several times with 0.5 mole sodium bicarbonate solution. All lipid materials were removed by filtration after keeping the sodium bicarbonate extract overnight in a separating funnel. Finally, the pH of the solution was brought down to 2.0 and the toxin was extracted from the concentrate into chloroform by repeated extraction with a liquots of chloroforms. The extract was pooled and concentrated and crude toxin isolated (Dhanasekaran, *et al.,* 2009).

Ochratoxin was detected by Thin Layer Chromatography as bright blue color extract. Identification, extraction and purification of Ochratoxin were carried following Dhanasekaran *et al.,* (2009) procedure.

Stocking and Acclimatization / Feeding of Broilers

On arrival all thirty birds was first weighed and housed together in a large cage constructed in the animal house. The floor of the cage was covered with cartons that absorbed moisture and provided warmth and 24 hours Light from electric bulb kept at 50cm height above the ground and kerosene lamp was used as supplement on very cold days to keep birds warm and maintain cage temperature. The cage was provided with two large clean feeders and drinkers. Birds were fed twice daily and all necessary vaccination and medication was administered to the birds accordingly. Chick on hatching and stocking were vaccinated against Marek's and New castle disease.

Acclimatization / first feeding of broilers: The thirty (30) day old broiler birds were fed with pure commercial starter mash for 4 Weeks without inclusion of Ochratoxin concentration. This is because younger birds are more susceptible to Ochratoxin concentration and could die due to toxicity (Edds *et al.,* 993). During this period, of acclimatization the birds were well adapted to their new environment and to one another.

Second Feeding: The broilers birds were randomly divided into three Groups (1-3), in three separate cages each containing ten (10 birds. Each bird was wing marked and each Group was housed in separate pens. At 5-8 Weeks, each Group was fed with feed containing corresponding amount of Ochratoxin. Feed of four days' storage time was purchased and tested in the lab to ensure there was no presence of Ochratoxin producing fungi.

Group1–was fed with feed containing no Ochratoxin concentration
Group2–0.6ml Ochratoxin concentrates
Group3–1.2ml Ochratoxin concentrates.

The appropriate Ochratoxin concentration was included into corresponding feed quantity based on treatment. After mixing the feed was air dried before being used to feed the birds. Feed was weight using weighing balance and expressed in kilograms (kg).

Ambient temperature, lightening, thunder and other environmental condition was kept optimum according to the requirements laid down in the technical instructions for broiler breeding by Obori *et al.,* (2005).

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Experimental design / treatment of birds

The experiment consisted of three treatment Groups with different treatment concentration.

Group1: Birds in this Group were the control and were fed with pure commercial finisher mash with no treatment concentration.
Group2: Birds in this Group were fed with feed containing 0.6ml concentration of Ochratoxin.
Group3: Birds in this Group were fed with feed containing 1.2ml Ochratoxin concentration.

A 2ml insulin syringe was used to administer the various concentration of aflatoxin.

Data was collected weekly on the following parameters;

Body Weight (WG): Body weight was taken weekly to determine the average weight gain per chick for the different treatment Groups. The weight gain was calculated as the difference between the weight in the previous week and the weight in the present week. It is calculated thus,

Weight Gain = Final weight–Initial weight

Feed intake (FI): Feed Intake was taken daily to calculate the quantity of feed consumed by each bird. The feed before feeding was weighed and recorded and the feed after the birds have eaten for the day was also recorded. The final quantity of feed was subtracted from the initial. It is calculated thus,

Feed Intake = feed before feeding – feed after feeding

Feed conversion ratio (FCR): This is the total quantity of feed each bird converts to food. The bird and Feed Intake weight was taken weekly to determine the FCR per Groups. FCR was calculated by dividing the amount of feed consumed in kilogram by the body weight gained in kilogram.

The greater the deviation of the feed from the Feed Consumed the lesser the Feed Convention Ratio and thus the lower the Growth Rate.

FCR = Feed Intake ÷ Weight Gain = F .I ÷ W .G

Mortality rate (M.R) = number of death / number of total chicks × 100 / 1

Statistical analysis: All the results were subjected to analysis of variance (ANOVA). Treatment means with significant differences was separated using the Ficher's Least Significant Difference (LSD) test at 5% probability level.

Duration of study: The duration of the study was 8 Weeks; the study began in the month of April to July. The first 4 Weeks was without treatment and the last 4 Weeks with treatment.

Ethical Considerations: The study adhered to ethical guidelines and approval was obtained from the animal ethics committee, ministry of Agriculture, Calabar, Cross River state. All procedures were conducted with minimal discomfort to the animals, following standard welfare practices.

IV. Result and Discussion

Result

Table 1 presents a comprehensive summary of the effects of ochratoxin A (OTA) contamination on broiler birds, focusing on key performance metrics such as weight gain, feed intake, feed conversion ratio, and mortality across various OTA concentrations over a four-week period. This table provides a detailed overview of how different levels of OTA in feed impact broiler performance, highlighting the overall effects observed during the study.

In the study, broiler birds were exposed to three different OTA concentrations, with the control group receiving no OTA contamination (0 ml/1.5 kg), Treatment 1 with 0.6 ml/1.5 kg, and Treatment 2 with 1.2 ml/1.5 kg. The results indicate that the control group consistently demonstrated superior performance across all measured parameters. Specifically, the control group achieved the highest mean weight gain, averaging 1.54 ± 0.35 kg over the four weeks. This was notably higher compared to Treatment 1, which had a mean weight gain of 1.36 ± 0.27 kg, and Treatment 2, which recorded the lowest mean weight gain of 1.28 ± 0.34 kg.

Similarly, feed intake was highest in the control group, reflecting its superior growth performance. The control group also exhibited the best feed conversion ratio, indicating more efficient use of feed. As OTA concentration increased, both feed intake and feed conversion ratio declined, illustrating the detrimental impact of higher OTA levels on these performance metrics.

The data also reveals a clear trend where increased OTA concentrations in the feed corresponded with reduced weight gain, lower feed intake, and decreased feed conversion efficiency. This pattern underscores the negative effects of OTA contamination on broiler birds, as higher levels of OTA in the feed are associated with diminished growth and feed utilization.

Furthermore, the results highlight that the duration of the exposure period also influenced the performance metrics. Longer exposure periods correlated with a greater impact on weight gain, feed intake, and feed conversion ratio. This

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suggests that OTA's adverse effects become more pronounced with extended exposure, further emphasizing the importance of managing OTA contamination to minimize its impact on poultry production.

Overall, Table 1 illustrates the significant impact of OTA contamination on broiler performance, with higher OTA concentrations leading to reduced weight gain, feed intake, and feed conversion efficiency. These findings underscore the importance of monitoring and controlling OTA levels in poultry feed to ensure optimal growth and performance of broiler birds.

Table 1: Showing a comprehensive summary of the effects of ochratoxin A (OTA) contamination on broiler birds

Parameters;	Control (0 ml/1.5 kg)	Trt 1 (0.6 ml/1.5 kg)	| Trt 2 (1.2 ml/1.5 kg) |	Week 1	Week 2	Week 3	Week 4	Significance
Weight Gain (kg)	$1.18^{a} \pm 0.11$	$1.10^{a} \pm 0.13$	$\|0.93^{b} \pm 0.10$	$1.33^{c} \pm 0.07$	$1.31^{c} \pm 0.17$	$1.23^{d} \pm 0.18$	$1.61^{n} \pm 0.07$	S
Feed Intake (kg)	$1.37^{c} \pm 0.14$	$1.36^{c} \pm 0.17$	$1.32^{a} \pm 0.14$	$1.44^{b} \pm 0.06$	$1.35^{a} \pm 0.14$	$1.33^{a} \pm 0.15$ |	$1.25^{e} \pm 0.15$ |	S
Feed Conversion Ratio	$1.02^{a} \pm 0.08$	$0.96^{b} \pm 0.01$	$1.02^{a} \pm 0.06$	$1.05^{a} \pm 0.09$	$1.13^{a} \pm 0.02$	$0.73^{b} \pm 0.01$	$1.20^{a} \pm 0.08$	S
Mortality	0	0	0	0	0	0	0	NS

Results are presented as mean ± standard error, means with different superscript letter along the each horizontal array differs significantly (P> 0.05).

Notes: Significance Key: - S: Statistically significant - NS: Not significant

Weight Gain: Significant differences observed among treatments with control and higher OTA concentrations showing greater weight gain.

Feed Intake: Significant variations in feed intake across different treatment groups and weeks.

Feed Conversion Ratio: Significant differences indicating varying efficiency in feed conversion among different OTA concentrations.

Mortality: No significant differences; all groups showed similar mortality rates with occasional incidents observed.

This summary highlights the impact of OTA contamination on key performance indicators in broiler birds, demonstrating significant effects on weight gain, feed intake, and feed conversion ratio, while mortality remained consistent across all treatment groups.

Body weight:

The result shows that there was a significant difference ($p<0.05$) in the body weight and concentration/level of Ochratoxins present in the feed. The control with 0ml/1.5kg of Ochratoxins had more body weight, followed by Treatment 1 with 0.6ml/1.5kg Ochratoxins as feed contaminant, Treatment 2 with 1.2ml/1.5kg Ochratoxins as feed contaminant. Analysis of variance (ANOVA) also showed there was a significant difference ($p<0.05$) in the level of interaction between the Concentration of Ochratoxins and Age of the birds across the various Groups (Figure 1).

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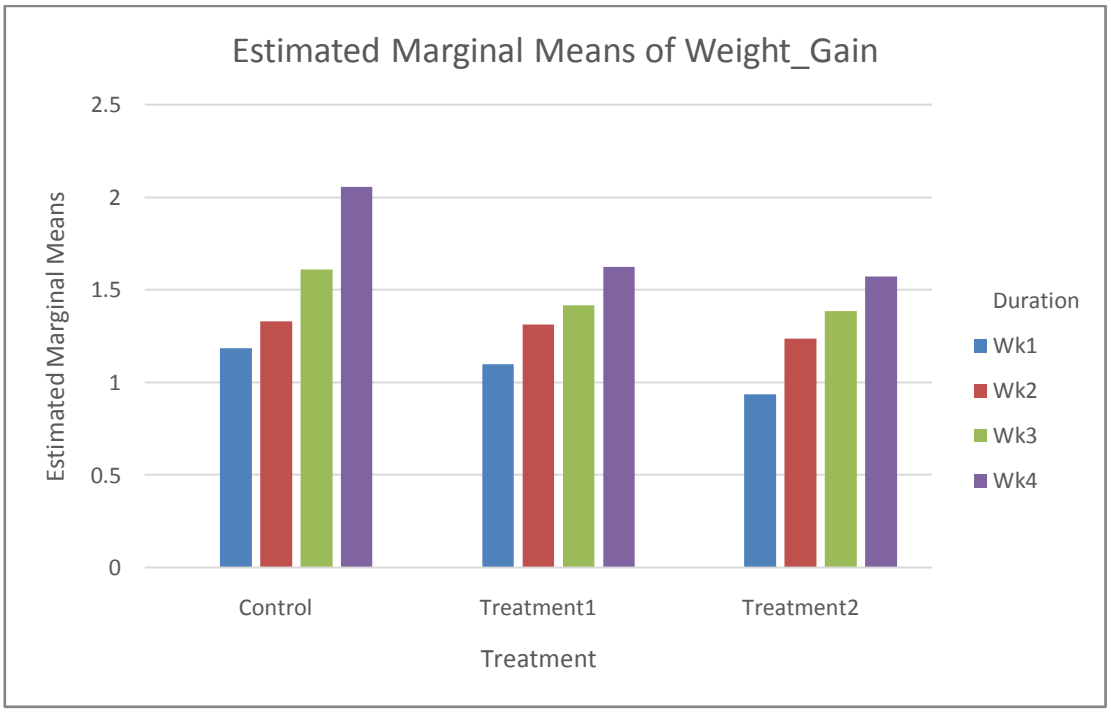

Figure 1: Showing level of interaction between the Concentration of Ochratoxins and Age of the birds across the various Groups

Feed intake:

The result shows that there was a significant difference ($p<0.05$) in the feed intake and concentration/level of Ochratoxins present in the feed. The control with 0ml/1.5kg of Ochratoxins had more feed intake, followed by Treatment 1 with 0.6ml/1.5kg Ochratoxins as feed contaminant, Treatment 2 with 1.2ml/1.5kg Ochratoxins as feed contaminant had the lowest mean feed intake (Table 3). Analysis of variance (ANOVA) also showed that there was a significant difference in the feed intake recorded across the various treatment group (Figure 2).

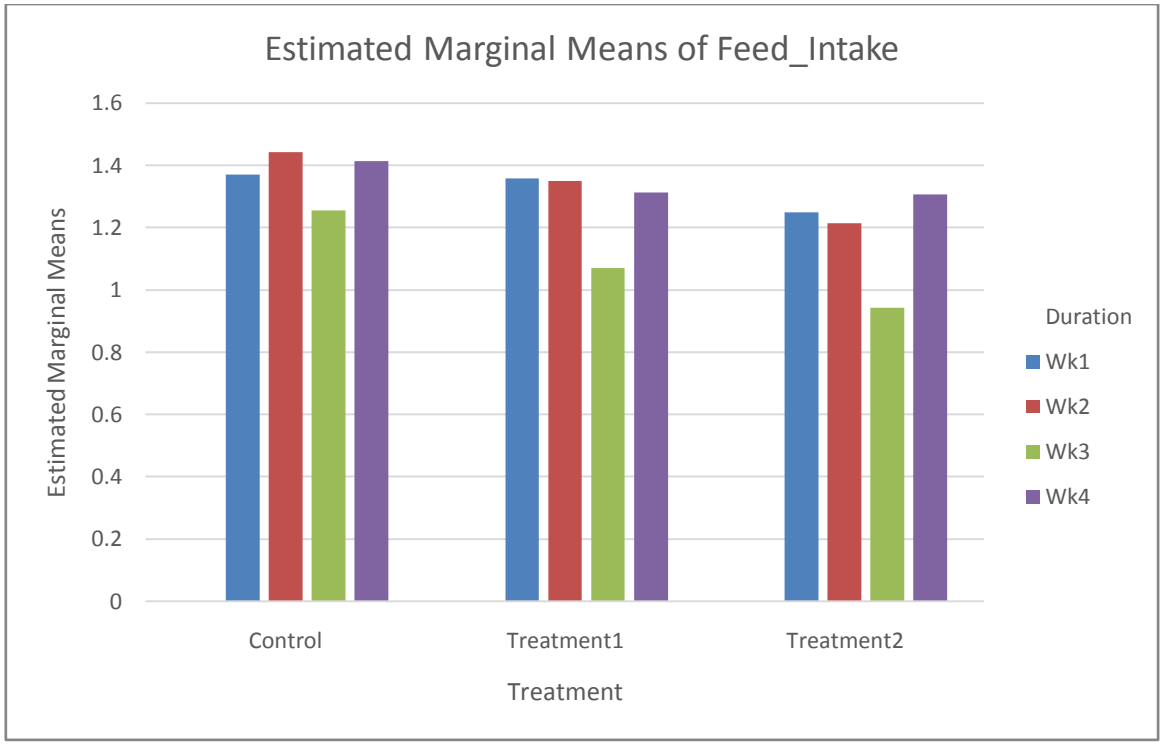

Figure 2: Showing difference in the feed intake recorded across the various treatment group

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Feed conversion ratio:

The result shows that there was a significant difference ($p<0.05$) in the feed conversion ratio and concentration/level of Ochratoxins present in the feed. The control with 0ml/1.5kg of Ochratoxins had the highest feed conversion ratio, followed by Treatment 1 with 0.6ml/1.5kg Ochratoxins as feed contaminant, Treatment 2 with 1.2ml/1.5kg Ochratoxins as feed contaminant had the lowest feed conversion ratio (Table 4). Analysis of variance (ANOVA) also showed that there was a significant difference in the feed intake recorded across the various treatment group.

Table 2: Effect of age (weeks) and concentration of Ochratoxins on weekly body weight (BW) in kg across the various groups

Treatment	Week 1	Week 2	Week 3	Week 4
Control (0ml/1.5kg)	$1.18^{a} \pm 0.11$	$1.33^{c} \pm 0.07$	$1.61^{n} \pm 0.07$	$2.05^{b} \pm 0.15$
Treatment 1 (0.6ml/1.5kg)	$1.10^{a} \pm 0.13$	$1.31^{c} \pm 0.17$	$1.41^{j} \pm 0.27$	$1.62^{b} \pm 0.23$
Treatment 2 (1.2ml/1.5kg)	$0.93^{b} \pm 0.10$	$1.23^{d} \pm 0.18$	$1.38^{r} \pm 0.37$	$1.58^{ab} \pm 0.27$

* Results are presented as mean ± standard error
* Means with different superscript letters along each vertical and horizontal array differ significantly ($p>0.05$)

Table 3: Effect of age (weeks) and concentration of Ochratoxins on weekly feed intake (FI) in kg across the various groups

Treatment	Week 1	Week 2	Week 3	Week 4
Control (0ml/1.5kg)	$1.37^{c} \pm 0.14$	$1.44^{b} \pm 0.07$	$1.25^{n} \pm 0.07$	$1.41^{b} \pm 0.15$
Treatment 1 (0.6ml/1.5kg)	$1.36^{c} \pm 0.17$	$1.35^{c} \pm 0.17$	$1.09^{j} \pm 0.27$	$1.31^{b} \pm 0.23$
Treatment 2 (1.2ml/1.5kg)	$1.32^{a} \pm 0.14$	$1.33^{d} \pm 0.18$	$1.07^{r} \pm 0.37$	$1.34^{ab} \pm 0.27$

*Results are presented as mean ± standard error
* Means with different superscript letters along each vertical and horizontal array differ significantly ($p>0.05$)

Table 4: Effect of age (weeks) and concentration of Ochratoxins on weekly feed conversion ratio (FCR) in kg across the various groups

Treatment	Week 1	Week 2	Week 3	Week 4
Control (0ml/1.5kg)	$1.02^{c} \pm 0.08$	$1.05^{b} \pm 0.09$	$1.20^{n} \pm 0.08$	$1.35^{b} \pm 0.07$
Treatment 1 (0.6ml/1.5kg)	$0.06^{c} \pm 0.01$	$1.13^{c} \pm 0.02$	$0.98^{j} \pm 0.03$	$0.86^{b} \pm 0.04$
Treatment 2 (1.2ml/1.5kg)	$1.02^{a} \pm 0.06$	$0.73^{d} \pm 0.01$	$0.84^{r} \pm 0.02$	$0.83^{ab} \pm 0.02$

*Results are presented as mean ± standard error
* Means with different superscript letters along each vertical and horizontal array differ significantly ($p>0.05$)

Mortality rate:

There was a low mortality rate; the control group (0ml/1.5kg) had no mortality throughout the duration. Treatment 1 (0.6ml/1.5kg) had two mortality at week 3. Treatment 2 (1.2ml/1.5kg) had no mortality. (Table 5)

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Table 5: Mortality of birds at different weeks across various groups

Treatment	Week 1	Week 2	Week 3	Week 4
Control (0ml/1.5kg)	0	0	0	0
Treatment 1 (0.6ml/1.5kg)	0	0	2	0
Treatment 2 (1.2ml/1.5kg)	0	0	0	0

V. Discussion

The results presented in Table 1 underscore the substantial impact of ochratoxin A (OTA) contamination on broiler poultry performance. As illustrated, OTA contamination adversely affects weight gain, feed intake, and feed conversion efficiency, highlighting the critical need for effective management strategies to mitigate these negative effects.

Impact on Weight Gain

The control group, which received no OTA contamination, consistently outperformed the treatment groups in terms of weight gain. Over the four-week period, broilers in the control group exhibited a significantly higher average weight gain (1.54 ± 0.35 kg) compared to those in Treatment 1 (1.36 ± 0.27 kg) and Treatment 2 (1.28 ± 0.34 kg). This decrease in weight gain with increasing OTA concentration is consistent with previous research that highlights OTA's detrimental effects on growth performance in poultry. OTA is known to induce a range of toxic effects, including reduced nutrient absorption and impaired protein synthesis, which directly impact growth rates (Masoero *et al.*, 2012; Samaržija *et al.*, 2017).

The observed reduction in weight gain with higher OTA levels can be attributed to the toxin's nephrotoxic and immunosuppressive properties. OTA primarily affects the kidneys, leading to impaired metabolic functions and reduced overall health, which in turn hampers growth (Sweeney & Dobson, 1998). Furthermore, OTA's impact on the liver can disrupt various metabolic processes essential for optimal growth, exacerbating the reduction in weight gain observed in broiler birds exposed to higher OTA concentrations.

Effects on Feed Intake

Feed intake data reveal a similar trend, with the control group showing the highest mean feed intake and the treatment groups exhibiting a progressive decrease. The control group's feed intake was significantly higher compared to Treatment 1 and Treatment 2, reflecting the adverse effect of OTA on appetite and feed consumption. As OTA concentration increased, feed intake decreased, aligning with findings from other studies that demonstrate OTA's negative impact on feed consumption (Masoero *et al.*, 2012; Samaržija *et al.*, 2017).

The decrease in feed intake with higher OTA levels can be linked to the toxin's effects on the gastrointestinal tract and overall health. OTA can induce oxidative stress and inflammation in the digestive system, leading to reduced feed intake and altered feeding behavior (Masoero *et al.*, 2012). Additionally, the stress associated with OTA toxicity can reduce appetite and feed consumption, further contributing to the observed decline in feed intake.

Feed Conversion Ratio

The feed conversion ratio (FCR) also demonstrated significant variation across different OTA concentrations. The control group had the most favorable FCR, indicating more efficient feed utilization. In contrast, both Treatment 1 and Treatment 2 showed increased FCR values, reflecting decreased feed efficiency. This trend is consistent with the body of literature indicating that OTA negatively affects feed conversion efficiency in poultry (Sweeney & Dobson, 1998; Samaržija *et al.*, 2017).

The impaired feed conversion ratio observed in OTA-exposed birds can be attributed to several factors. OTA's impact on nutrient absorption and metabolism, coupled with its toxic effects on vital organs such as the liver and kidneys, reduces the efficiency with which feed is converted into body mass. The toxin's interference with metabolic processes and its contribution to overall poor health likely contribute to the observed inefficiencies in feed utilization (Masoero *et al.*, 2012).

Mortality Rates

Mortality rates across the different OTA concentrations remained relatively consistent, with no significant differences observed among the groups. This finding suggests that while OTA contamination significantly affects growth performance, it may not substantially impact mortality rates in the short

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term. However, it is important to note that prolonged exposure to OTA can have cumulative adverse effects on overall health and may influence mortality rates over a longer duration (Sweeney & Dobson, 1998).

Duration of Exposure

The results also indicate that the impact of OTA contamination on weight gain, feed intake, and feed conversion ratio becomes more pronounced with extended exposure. This finding highlights the cumulative nature of OTA's adverse effects, which become more evident over time. As OTA exposure continues, its detrimental impact on health and performance becomes increasingly significant, underscoring the importance of managing OTA contamination to minimize its long-term effects (Masoero *et al.*, 2012).

Implications for Poultry Management

The findings of this study underscore the critical need for effective strategies to manage OTA contamination in poultry feed. Regular monitoring of feed ingredients for OTA contamination, implementing feed additives to reduce toxin levels, and maintaining rigorous quality control measures in feed production are essential for mitigating the impact of OTA on poultry health and performance (Samaržija *et al.*, 2017). Additionally, enhancing public awareness about the risks associated with OTA contamination and promoting safer feed practices can contribute to improved poultry health and production outcomes.

In conclusion, OTA contamination poses a significant threat to broiler poultry performance, affecting weight gain, feed intake, and feed conversion efficiency. Effective management and mitigation strategies are crucial for minimizing the adverse effects of OTA and ensuring optimal growth and productivity in broiler birds. Continued research and innovation in mycotoxin management will be essential for addressing this challenge and enhancing the sustainability of poultry production.

VI. Summary and Recommendations

Summary

The study investigated the effects of ochratoxin A (OTA) contamination on the growth performance of broiler birds, focusing on key parameters such as weight gain, feed intake, feed conversion ratio, and mortality over a four-week period. OTA is a mycotoxin produced by certain fungi and is known to have detrimental effects on poultry health and productivity.

The results indicated that OTA contamination significantly impairs broiler performance. The control group, which received no OTA contamination, consistently demonstrated superior growth performance, with the highest mean weight gain (1.54 ± 0.35 kg), feed intake, and the most efficient feed conversion ratio. In contrast, broilers exposed to OTA showed reduced weight gain, lower feed intake, and less efficient feed conversion. Specifically, birds in Treatment 1 (0.6 ml/1.5 kg) and Treatment 2 (1.2 ml/1.5 kg) had progressively lower performance metrics compared to the control group.

The decrease in weight gain, feed intake, and feed conversion ratio with increasing OTA concentrations underscores the toxin's adverse effects on poultry. OTA's impact on weight gain was substantial, with Treatment 2 exhibiting the lowest average gain (1.28 ± 0.34 kg). Feed intake also declined with higher OTA levels, and feed conversion efficiency worsened, reflecting the toxin's interference with nutrient absorption and metabolic processes. Despite these significant effects on performance, mortality rates remained consistent across all groups, indicating that OTA's immediate impact may not directly influence survival rates within the study's duration.

The results also highlighted the cumulative nature of OTA's adverse effects, with prolonged exposure exacerbating the negative impact on growth and feed efficiency. This emphasizes the importance of effective management strategies to mitigate OTA contamination in feed.

Recommendations:

1. Enhanced Monitoring and Control:

Regular monitoring of feed ingredients for OTA contamination is essential. Implementing stringent quality control measures in feed production and storage can help reduce OTA levels in poultry feed. Establishing protocols for the regular testing of feed and environmental conditions will aid in early detection and prevention of contamination.

2. Use of Mycotoxin Binders and Detoxifiers:

Incorporating mycotoxin binders and detoxifiers into poultry feed can mitigate the effects of OTA. These additives can bind OTA in the gastrointestinal tract, reducing its absorption and subsequent toxic effects. Selecting effective products and following recommended inclusion rates can enhance feed safety and bird health.

3. Improved Feed Storage Practices:

Proper storage of feed is crucial to minimize OTA contamination. Ensuring that feed is stored in dry, cool environments and avoiding conditions that promote fungal growth will help reduce the risk of OTA contamination.

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Regular inspection and maintenance of storage facilities should be conducted to prevent mold growth.

4. Educating Poultry Producers:

Raising awareness among poultry producers about the risks associated with OTA and the importance of effective feed management is critical. Providing training and resources on best practices for feed handling, storage, and contamination prevention can support better management of OTA risks.

5. Research and Development:

Continued research into the development of more effective mycotoxin control strategies and alternative feed additives is necessary. Investigating the interactions between OTA and different feed components, as well as exploring new methods for detoxifying or neutralizing mycotoxins, will contribute to improved poultry health and productivity.

6. Regulatory Compliance:

Adhering to regulatory standards and guidelines for maximum allowable levels of OTA in feed is crucial. Poultry producers should stay informed about relevant regulations and ensure compliance to maintain feed safety and protect poultry health.

In conclusion, OTA contamination poses a significant challenge to broiler production, affecting growth performance and feed efficiency. Implementing comprehensive management strategies, improving feed safety practices, and supporting ongoing research are essential steps toward mitigating the impact of OTA and ensuring the sustainability of poultry production.

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