Research Article

Effects of Administering Fungi Isolated from Poultry Feed on Some Physiological and Productive Parameters in Rose Chickens in Several Regions of the Karbala Governorate

Mohanad Fadhl Hussain Al-Musodi*, Zeinab A.M. Al-Tememe, Mustafa Hadi Hamid

Department of Animal Production, College of Agriculture, University of Kerbala, Iraq.

Abstract | Research have shown that supplementation with probiotic fungi improves digestive health and reduces populations of harmful bacteria in birds. This study aimed to evaluate the impact of fungi isolated from poultry feed collected from various regions of Karbala Governorate, Iraq, on selected physiological and productive traits in broilers. A total of 180 broiler chicks were used, divided into three equal groups. Each group was further divided into six replicates of 10 chicks each. The second group received a dose of 1 ppm *Aspergillus flavus*, while the third group received 1 ppm *Aspergillus niger*. The first group, which was not exposed to fungal contamination, served as the control. Both fungal species, *Aspergillus flavus* and *Aspergillus niger*, were isolated from poultry feed. The study measured productive parameters including body weight, weight gain, feed conversion ratio (FCR), and feed intake, along with physiological parameters such as blood cell counts, lipid profile, blood proteins, and liver and kidney function indicators. The results showed that the third group (*A. niger*) had significantly higher average weekly weight compared to the other groups ($P < 0.05$). In the second group (*A. flavus*), there was a significant increase in white blood cells, red blood cells, hemoglobin, and lymphocyte percentage compared to the control group ($P < 0.05$). Both treatment groups exhibited a reduction in total cholesterol compared to the control, while high-density lipoprotein (HDL) levels were significantly higher in the third group than in the others ($P < 0.05$). Regarding blood proteins, the third group showed significantly higher levels than both the second group and the control ($P < 0.05$). However, liver enzymes and creatinine were elevated in the second group, indicating potential hepatic and renal stress in birds exposed to *A. flavus*. In conclusion, inclusion of *A. niger* in the diet of broilers exhibited some beneficial effects as compared to *A. flavus*.

Keywords | Fungi, Poultry feed, Physiological, Productive, Rose type broiler

Received | February 09, 2025; **Accepted** | April 27, 2025; **Published** | May 26, 2025
***Correspondence** | Mohanad Fadhl Hussain Al-Musodi, Department of Animal Production, College of Agriculture, University of Kerbala, Iraq; **Email:** Mohanad.fadhl@uokerbala.edu.iq
Citation | Al-Musodi MFH, Al-Tememe ZAM, Hamid MH (2025). Effects of administering fungi isolated from poultry feed on some physiological and productive parameters in rose chickens in several regions of the Karbala Governorate. J. Anim. Health Prod. 13(2): 393-401.
DOI | https://dx.doi.org/10.17582/journal.jahp/2025/13.2.393.401
ISSN (Online) | 2308-2801

INTRODUCTION

The economic cost of feed significantly influences the growth of the livestock sector and constrains animal production. Therefore, rationing feed while maintaining production quality and quantity is crucial. Numerous researchers have explored the use of low-cost feed additives in minimal ratios to enhance the quality and quantity of meat, eggs, and other products by improving feed quality with additives not suitable for human consumption (Ayoola *et al.*, 2024; Classen and Coppe, 1998). Agricultural animals, including broilers, can convert low-quality feed unsuitable for humans into high-quality animal protein, with feed accounting for about 75% of total poultry farming costs (Atteh, 2004).

Poultry can be exposed to various pathogens, including fungi and their toxins, through the consumption and digestion of contaminated feed especially yellow corn (Canas and Aranda, 1996; Al-Tememe *et al*., 2025). Fungal contamination of poultry feed is a global issue, leading to altered blood parameters, impaired liver function, reduced growth and development, and significant economic losses for poultry meat and egg producers (Che *et al*., 2011). Additionally, fungi can also be found in broiler drinking water and airborne dust (Ibrahim *et al*., 2021). *Aspergillus* species can affect birds of any age and in any environment (Abd El-Ghany, 2021).

The high concentration of fungi or their toxins in the feed leads to an increase in the percentage of halogens, a decrease in red blood cells, egg production, deterioration of the nutritional conversion rate, inhibition of immune system function, decreased response to vaccines, and pathological changes in the liver and other parts of the bird's body (Kamalavenkatesh *et al*., 2005). Studies have pointed to a scientific fact that the higher the concentration of mycotoxins, the activity the immune system is inhibited, the effectiveness of phagocytic cells decreases, and lymphocytes decrease (Fung and Clark, 2004). *Aspergillus flavus* produces mycotoxins specifically aflatoxins B1, B2, G1, and G2 which commonly contaminate cereals such as wheat, yellow corn, and soybeans at various stages of production (Cole and Richard, 1993). Among these, aflatoxin B1 is considered the most harmful to poultry, leading to symptoms like reduced appetite, poor weight gain, decreased feed intake, impaired feed conversion ratio, and even mortality (Girish and Devegowda, 2006). The liver is the primary target organ affected by mycotoxins (Miazzo *et al*., 2000), and mycotoxin contamination has long been a challenge in the poultry industry (Kubena *et al*., 1993). In contrast, *Aspergillus niger* exhibits biostimulant properties and is commonly found in nature and easily cultured in laboratories (Piva *et al*., 1995). It is a valuable source of bioactive compounds such as citric, gluconic, and itaconic acids, and it produces beneficial enzymes like protease, cellulase, xylanase, and phytase, which support bird health and can enhance the economic efficiency of poultry farming (Nadumane *et al*., 2016).

As a bio-enhancer, proprebiotics (when alive) and prebiotics (when inactivated) support the growth of beneficial gut bacteria in poultry and help birds utilize the physiologically active secondary metabolites produced by fungi (Hong *et al*., 2004). Previous studies have shown that supplementation with *Aspergillus niger* improves digestive health and reduces populations of *E. coli* and *Salmonella* in birds (Saleh *et al*., 2017).

The aim of the study was to make a comparison between the effect of two types of fungi that were isolated from a poultry feed in Karbala on some productive and physiological parameters in broiler.

MATERIALS AND METHODS

This study was conducted at the Animal Field, Faculty of Agriculture, Karbala University, using 180 broiler chickens of the Rose breed. The experimental birds were reared and handled in line with all ethical standards and study protocols were approved by the University of Kerbala. The birds were randomly assigned to three equal groups, with each group further divided into six replicates of 10 chicks each. All birds were maintained on a standard balanced diet. The second group received a 1 ppm solution of *Aspergillus flavus*, while the third group was dosed with a 1 ppm solution of *Aspergillus niger*. The first group, which received no fungal treatment, served as the control.

Isolation and diagnosis of fungi used in the study

A. flavus and *A. niger* fungi were isolated from poultry feed pellets in Karbala, Iraq, using a modified method described by Ali *et al*. (1991) and identified according to the procedure outlined by Kayode and Sani (2008).

Productive parameters

Body weight and feed efficiency were measured weekly, starting from the seventh day of the experiment. Each chick was individually weighed on the first day, and this procedure was repeated every weekend throughout the trial. Live body weight and weight gain were calculated using the method described by Al-Musodi *et al*. (2024), by subtracting the bird's weight at the start of the week from its weight at the end of the week.

Feed consumption was determined based on the actual feed intake of each group, following the method of Tarrage and Puchal (1977). It was calculated by subtracting the amount of feed remaining at the end of the week from the amount provided at the beginning.

The feed conversion ratio (FCR), which indicates feed efficiency, was calculated using the following formula:

$$FCR = Feed\ consumed\ (g)/Average\ weight\ gain\ (g)$$

This value represents the grams of feed required to produce one gram of body weight gain (Al-Musodi *et al*., 2024).

Blood collection

At the end of the rearing period, blood samples were collected from the birds' jugular veins. A total of 5 mL of blood was drawn from each bird and divided into two tubes. One tube contained an anticoagulant for the

analysis of white blood cells, hemoglobin, packed cell volume (PCV), and leukocyte counts. The second tube, left without anticoagulant, was used to collect serum for the measurement of lipid profile, liver enzyme activity, and blood protein levels.

Hematological analysis

Bird blood cells were diluted using Natt and Herrick solution and analyzed using the hemocytometer counting method, following the procedure described by Campbell (1988). For red blood cell (RBC) counting, 0.5 mL of blood was drawn and diluted with the solution to the 101 mark, resulting in a 1:200 dilution. For white blood cell (WBC) counting, the same volume of blood was diluted to the 11 mark, yielding a 1:20 dilution. The cells were then counted using standard hemocytometer procedures.

Differential leucocyte counts were performed by preparing a blood smear. A drop of blood was placed on one end of a clean glass slide, and another slide held at a 45° angle was used to spread the blood into a thin film. After air-drying, the smear was stained with Wright's stain, gently rinsed, and dried again. The slide was examined under an oil immersion lens, and 100 leukocytes were counted. The different types of white blood cells were identified based on morphological characteristics, as per the method of Burton and Harrison (1969).

Packed Cell Volume (PCV) was measured by collecting blood in heparinized capillary tubes after puncturing the wing vein. One end of the tube was sealed with artificial clay, and the tube was centrifuged at 12,000 rpm for 5 minutes using a hematocrit centrifuge. PCV was then determined using a hematocrit reader, following Campbell's (1988) method.

Hemoglobin concentration was estimated using Drabkin's solution, which converts hemoglobin to cyanmethemoglobin. A volume of 20 µL of blood was mixed with 5 mL of Drabkin's solution and allowed to react for 5 minutes. The mixture was then centrifuged at 2,500 rpm for 5 minutes, and absorbance was read at 540 nm using a spectrophotometer. The spectrophotometer was zeroed with Drabkin's solution, in accordance with Varley and Bell (1980).

Determination of the total protein level in the blood

The Biuret Method, described by Wotton (1964), was applied to measure the total protein concentration in the blood. This method is based on the interaction between copper ions in the biuret reagent and protein peptides in an alkaline medium, forming a violet-colored complex. The Rodkey (1965) method was employed to measure the albumin concentration in the blood. To determine the globulin concentration, the total protein level was subtracted by the albumin concentration, as described by Ghanim *et al.* (2016).

Determination of lipid profile

Serum total cholesterol concentration (mg/dL) was measured using a commercial kit (Spinreact, Spain) following the procedure outlined by Allian *et al.* (1974). Triglyceride levels were also determined with a commercial kit (Spinreact, Spain), following the method described by Fossati and Prencipe (1982).

High-Density Lipoprotein (HDL-C) concentration (mg/dL) was measured using a commercial kit (Spinreact, Spain), as per the procedure outlined by Tietz (1995). Similarly, Low-Density Lipoprotein (LDL-C) concentration (mg/dL) was calculated using the method of Buritus and Ashwood (1999) with the following equation:

$$LDL\text{-}C\ concentration\ (mg/dL) = Total\ cholesterol - (HDL\text{-}C + vLDL\text{-}C)$$

Very Low-Density Lipoprotein (vLDL-C) concentration (mg/dL) was measured according to Buritus and Ashwood (1999), using the following formula based on triglyceride levels:

$$vLDL\text{-}C\ concentration\ (mg/dL) = Triglycerides/5$$

Liver function enzymes

Alanine Aminotransferase (ALT) activity (U/L) was measured using the method described by Wroblewski and Ladue (1956). Aspartate Aminotransferase (AST) activity was quantified according to the procedure outlined by Jain (1986).

Renal function

The concentration of urea in the blood of meat chicks was determined using the method described by Chawla (1999), while the blood creatinine level was measured according to the method of Naseem *et al.* (2018).

Statistical analysis

Statistical analyses in this study were performed using SPSS 15.0. ANOVA was used to assess the significance of the main effects and interactions in the data. The Duncan Multiple Range Test was employed to compare the means. The significance threshold was set at $P < 0.05$ (SAS, 2010).

RESULTS AND DISCUSSION

Live body weight

It is noted from the Table 1 that the weights of the chicks

in the third group were significantly higher ($p<0.05$) than those of the control group and the second group in the fourth week of life. Additionally, the weights of the control group were significantly higher ($p<0.05$) than those of the second group in the same week. However, the chicks in the first and third groups showed similar weights.

Body weight gain

The chicks of the third group were significantly superior ($p<0.05$) in terms of weekly weight gain over the chicks of the second group in the last week of the study (Table 2).

Feed intake

It is noted that there were no significant differences ($p>0.05$) in the amount of feed intake between the chicks of the study groups, as shown in Table 3.

Feed conversion ratio (g/ week)

The addition of *A. niger* to the broiler chicks resulted in a significant ($p<0.05$) improvement in the feed conversion rate compared to the control and second groups in the forth week of the study, as shown in Table 4.

Blood cell parameters

The third group significantly ($p<0.05$) outperformed the second group in the number of red and white blood cells, hemoglobin levels, and the percentage of packed cell volume (PCV), while the control group surpassed the second group in the number of white blood cells, as shown in Table 5.

Differential leucocyte count

The results of the differential white blood cell count showed a significant ($p<0.05$) higher percentage of heterophils in the control group compared to the second group. In contrast, the second group significantly outperformed the control group in the percentage of lymphocytes and eosinophils, as shown in Table 6.

Table 1: The effect of treatment on weekly body weight (g/week) of broilers.

Groups/ week	1st week	2nd week	3rd week	4th week	5th week
Control	185.57±5.91	518.07±36.21	882.77±34.61	1482.08±31.23^{b}	2150.4±60.1^{a}
Group 2 (*A. flavus*)	174.81±20.11	489.01±30.13	810.11±13.54	1314.12±30.17^{c}	1892.15±58.07^{b}
Group 3 (*A. niger*)	178.84±8.73	532.24±31.02	982.14±13.15	1565.9±9.11^{a}	2254.9±71.02^{a}
LSD	45.04	126.11	94.12	82.91	201.4
P value	N.S	N.S	N.S	<0.05	<0.05

Table 2: The effect of treatment on weekly weight gain (g/week) of broilers.

Groups/ week	1st week	2nd week	3rd week	4th week
Control	332±50	364.70±25.40	599.30±37.41	668.40±24.64^{ab}
Group 2 (*A. flavus*)	314.2±30.71	321.10±32.18	504±61.60	578.04±99.34^{b}
Group 3 (*A. niger*)	353.40±20.14	449.90±40.01	583.74±17.90	689.05±29.11^{a}
LSD	90.06	111.91	154.12	104. 1
P value	N.S	N.S	N.S	<0.05

Table 3: The effect of treatment on feed intake (g/Week).

Groups/ week	1st week	2nd week	3rd week	4th week
Control	509.70±40.10	657.40±23.41	679.80±24.10	936.50±37.39
Group 2 (*A. flavus*)	440.81±70.10	627.97±25.01	677.80±29.60	805.17±36.06
Group 3 (*A. niger*)	478.40±21.17	624.40±27.51	807.10±27.31	808.19±61.40
LSD	97.11	88.40	590.10	163.90
P value	N.S	N.S	N.S	N.S

Table 4: The effect of treatment on feed conversion ratio (g/week).

Groups/ week	1st week	2nd week	3rd week	4th week
Control	1.53±0.4	1.80±1.24	1.13±0.10	1.40±0.32^{a}
Group 2 (*A. flavus*)	1.40±0.44	1.95±2.30	1.34 ±0.17	1.39±1.03^{ab}
Group 3 (*A. niger*)	1.35±0.90	1.38±1.13	1.38±3.21	1.17±0.33^{b}
LSD	0.713	0.631	0.591	0.291
P value	N.S	N.S	N.S	<0.05

Table 5: The effect of treatment on blood picture.

Groups/ week	Red Blood cells Cellx10^6	White blood cells Cellx10^3	Hemoglobin (Hb) g/dl	Packed cell volume (PCV) %
Control	45.26±0.7^{ab}	50.82±1.02^{ab}	8.80±0.12^b	29.48±0.50^a
Group 2 (*A. flavus*)	42.40±1.04^b	49.70±0.75^b	7.81 ±0.11^c	25.40±1.14^b
Group 3 (*A. niger*)	46.41±1.27^a	54.75±0.43^a	9.91±0.07^a	31.10±0.17^a
LSD	3.11	3.017	0.640	2.41
P value	<0.05	<0.05	<0.05	<0.05

Table 6: The effect of treatment on differential Leucocyte count (%).

Groups/week	Heterophil	Lymphocyte	Eosinophil	Basophil	Monocytes
Control	27.91±0.12^a	64.61±0.14^b	0.65±0.11^b	0.71±0.01	6.64±0.17
Group 2 (*A. flavus*)	25.17±0.41^b	66.94±2.91^a	0.78 ±0.13^a	0.75±0.03	6.84±0.44
Group 3 (*A. niger*)	26.99±0.71^{ab}	65.01±2.81^{ab}	0.86±0.14^a	0.75±0.04	6.75±0.30
LSD	1.12	2.04	0.11	0.170	1.301
P value	<0.05	<0.05	<0.05	N.S	N.S

Table 7: The effect of treatment on Lipid profile (µg/dl).

Groups/ week	cholesterol	Triglycerides	HDL	LDL	vLDL
Control	136.51±1.17^a	49.55±1.14	23.31±1.09^{ab}	102.11±1.14	9.91±0.83
Group 2 (*A. flavus*)	133.41±1.90^b	48.56±1.81	22.50 ±0.70^b	100.31±1.21	9.71±0.72
Group 3 (*A. niger*)	133.90±1.71^b	54.50±3.09	24.61±1.90^a	99.20±0.017	10.90±2.14
LSD	2.10	7.35	2.11	3.24	5.31
P value	<0.05	N.S	<0.05	N.S	N.S

Table 8: The effect of treatment on biochemical parameters.

Groups/ week	Total protein g/dl	Albumin g/dl	Globulin g/dl	AST u/l	ALT u/l	Urea mg/dl	Creatinine Mg/ dl
Control	3.33±0.42^b	1.42±1.14^a	1.91±0.31^{ab}	120.36±14.12^b	401.34±3.74^b	3.18±11.21	0.41±13.22^b
Group 2 (*A. flavus*)	3.01±012^b	1.31±0.43^b	1.70±0.36^b	129.31±13.98^a	411.60±6.14^a	3.21±14.2	0.47±17.12^a
Group 3 (*A. niger*)	3.63±0.1^a	1.44±0.4^a	2.19±0.3^a	122.14±15.0^{ab}	404.19±3.8^{ab}	3.27±20.1	0.43±21.0^{ab}
LSD	0.857	0.10	0.411	8.51	5.314	2.150	0.055
P value	<0.05	<0.05	<0.05	<0.05	<0.05	N.S	<0.05

Lipid profile

Fungal treatments influenced the blood lipid profile, with the total cholesterol concentration significantly higher ($p<0.05$) in the control group compared to the second group. Additionally, the concentration of high-density lipoproteins (HDL) was higher in the third group compared to the second group, as shown in Table 7.

Biochemical parameters

As shown in Table 8, the concentrations of total blood proteins, albumin, and globulin in the third group were significantly higher ($p<0.05$) compared to the second group. Additionally, the concentrations of the enzymes AST and ALT were significantly higher ($p<0.05$) in the second group compared to the third group. The concentration of creatinine was significantly higher ($p<0.05$) in the second group compared to the control group. However, the concentration of blood urea was not significantly affected by the treatment.

DISCUSSION

The improvement in the productive performance of broilers in the third group, as shown in Tables 1, 2, and 4, reflects the positive effects of *A. niger* on the gastrointestinal tract. This fungus enhances nutrient utilization particularly carbohydrates, polysaccharides, and enzymes by improving their digestion and releasing bioactive compounds that promote chick growth (Muhammed and Oloyede, 2010). *A. niger* also improves the digestion of complex substances due to its probiotic-like action (Muhammed and Oloyede, 2006), mediated by enzymes it secretes, such as pectinase, carbohydrase, lactase, invertase, and acid protease (Nagashima *et al.*, 1999). These enzymes boost

protein digestion and mineral absorption, both crucial for growth, weight gain, and overall health (Nelson and Cox, 2005). These findings align with those of Muhammed and Oloyede (2010), Omid *et al*. (2022), and Saleh *et al*. (2011), who reported increased broiler weights after *A. niger* supplementation.

The improved feed conversion ratio observed in the third group may also result from enhanced feed utilization due to *A. niger*'s enzymatic activity, consistent with previous findings in various animals (Muhammad *et al*., 2000; Omid *et al*., 2022; Kayode *et al*., 2008).

In contrast, the second group showed a significant ($p<0.05$) decline in productive traits compared to the control and third groups, likely due to the harmful effects of aflatoxins produced by *A. flavus* (Freire *et al*., 1996). This result agrees with earlier studies by Jeff-Agboola (2014), Nazarizadeh *et al*. (2019), and Khaleghipour *et al*. (2019), which reported negative impacts of aflatoxins on poultry performance.

Significant heterogeneity ($p<0.05$) was observed in the blood parameters, particularly a decrease in the second group, likely due to the effects of aflatoxins secreted by *A. flavus* (Anwar *et al*., 2001). Blood parameters are key indicators of an animal's health, and reductions in hemoglobin, packed cell volume (PCV), and erythrocyte count have similarly been reported in layer hens fed *A. flavus*-contaminated feed (Fawaz *et al*., 2022). Aflatoxins are known to trigger inflammation and cellular damage, contributing to these hematological disruptions, as also observed in turkey chicks (Javed *et al*., 2005), with findings supported by Basmacioglu *et al*. (2005).

In contrast, Table 5 shows a significant increase ($p<0.05$) in blood parameters in the third group. These findings align with Al-Kassie *et al*. (2008), who reported that probiotics significantly enhanced hemoglobin levels in broilers, improving oxygen delivery and reducing hypoxia risk. *A. niger* may contribute to better oxygen saturation and support the development and protection of red blood cells and their hemoglobin content (Pavlidis *et al*., 2007). Similar results were reported by Hao *et al*. (2020), who observed a significant increase in blood parameters in chicks supplemented with *A. niger* at different dietary levels (0.25%, 0.5%, 0.75%, and 1%).

As for differential leukocyte counts, Table 6 indicates a significant increase ($p<0.05$) in lymphocyte percentage in the second group, which may reflect the immunological stress caused by aflatoxin exposure. Aflatoxins contribute to anemia, cellular damage, and reduced red and white blood cell counts, consistent with the findings of Jeff-Agboola (2014). The elevated eosinophil levels in the second group could be attributed to hypersensitivity or inflammatory responses triggered by aflatoxins or fungal elements (Betina, 1989; Oguz *et al*., 2000), further supported by Anjorin and Cyriacus (2014).

The concentration of high-density lipoproteins (HDL) significantly increased ($p<0.05$) in the third group compared to both the control and second groups (Table 6), suggesting the beneficial role of *A. niger* in lowering harmful cholesterol levels (Al-Kassie *et al*., 2008; Kim *et al*., 2003). This effect may be attributed to the fungus's influence on the enzyme HMG-CoA reductase, which is critical in cholesterol biosynthesis and is known to be inhibited by fungal metabolites (Hajjaj *et al*., 2005). Similarly, Srinivasan *et al*. (2022) demonstrated reduced cholesterol levels in broilers supplemented with *A. niger* and probiotics, consistent with the findings of Saleh *et al*. (2011).

Further, *A. niger* may reduce hepatic cholesterol synthesis by suppressing liver enzyme activity and decreasing bile secretion (Tufan and Bolacali, 2017). Its role in enhancing short-chain fatty acid production in the intestine may also contribute to lower cholesterol formation in the liver (Tang *et al*., 2017). Increased HDL levels and reduced cholesterol could also stem from reduced lipid absorption in the intestine due to microbial activity stimulated by *A. niger* (Abul-Lateef *et al*., 2019; Awais *et al*., 2019). This may involve beta-fructan secretion by probiotic-associated fungi (Saleh *et al*., 2011; Hao *et al*., 2020).

In contrast, the decrease in cholesterol observed in the second group may result from the toxic effects of aflatoxins produced by *A. flavus* (Solis *et al*., 2019). Liu *et al*. (2018) similarly reported reduced cholesterol levels in broilers exposed to aflatoxins, likely due to impaired liver function and lipid metabolism.

The concentration of total protein, albumin, and globulin in the blood of the third group increased significantly ($p<0.05$) compared to both the second and control groups, as shown in Table 7. This improvement may be attributed to the role of *A. niger* in enhancing the utilization of organic compounds in the feed, particularly proteins (Abul-Lateef *et al*., 2019). In contrast, protein levels in the second group (*A. flavus*) were significantly lower ($p<0.05$) than those in the control group, likely due to the toxic effects of aflatoxins (Zou *et al*., 2023).

However, despite this reduction, the chicks' vital functions were not severely affected, possibly due to the low fungal dosage and relatively short rearing period (35 days), which the liver may have managed without major dysfunction (Lafi *et al*., 2010). These findings are consistent with those of Yunus *et al*. (2011), who also observed minimal physiological disruption at lower aflatoxin exposure levels

over short durations.

Fungi can influence liver cells in multiple ways, either negatively or positively, depending on the fungal species and the bioactive compounds or toxins they produce (Ozer et al., 2008). The significant increase ($p<0.05$) in liver enzyme levels observed in the second group (*A. flavus*) may be attributed to liver cell damage and increased cellular breakdown (Yunus *et al.*, 2011). Exposure of broiler chicks to mycotoxins is known to reduce blood protein levels while elevating liver enzymes (Soares *et al.*, 1989). In this study, the observed signs of anemia further suggest possible liver fibrosis, likely caused by aflatoxin exposure (Zou *et al.*, 2023). These findings are consistent with Liu *et al.* (2018b), who reported decreased total protein and albumin levels, alongside increased liver enzyme activity, in broilers administered aflatoxins derived from *A. flavus*.

The elevated creatinine levels observed in the second group (*A. flavus*) may be attributed to the effects of aflatoxin secretion, which can cause damage to kidney tissues. This damage likely impairs the kidneys' ability to effectively eliminate metabolic waste from the body (Khaleghipour *et al.*, 2019). These findings are consistent with those of Ukoha *et al.* (2023), who also reported increased blood creatinine concentrations in birds fed aflatoxin-contaminated feed.

CONCLUSIONS

According to the study, *A. flavus* negatively affects broiler growth and health parameters, while *A. niger* shows beneficial effects. Therefore, *A. niger* may be further explored using molecular techniques before being applied in commercial poultry production.

ACKNOWLEDGMENT

I extend my gratitude to the Faculty of Agriculture, Karbala University and to the Department of animal production to facilitate the task of conducting this study and provide the necessary laboratories and facilities for it. I would also like to thank the Journal of animal health and production for reviewing this study and correcting errors in it.

NOVELTY STATEMENT

This article is one of the most recent articles in the country where it was conducted.

AUTHOR'S CONTRIBUTION

The researchers contributed to the completion of this work with regular group work.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

REFERENCES

Abd-El-Ghany WA (2021). Avian aspergillosis: A potential occupational zoonotic mycosis especially in Egypt. Adv. Anim. Vet. Sci., 9(10): 1564-1575. https://doi.org/10.17582/journal.aavs/2021/9.10.1564.1575

Abdul-Lateef AN, Jameel YJ, Abbas R (2019). Effects of dietary prebiotics (SafMannan) and local Iraqi prebiotic on some blood biochemical parameters of broiler chickens. Pak. J. Nutr., 18(1): 80–85. https://doi.org/10.3923/pjn.2019.80.85

Ali S, Sayed A, Sarker RT, Ingrole R (1991). Factors affecting cellulase production by *Aspergillus terreus* using water hyacinth. World J. Microbiol. Biotechnol., 7: 62-66.

Al-Kassie GA, Al-Jumaa, Jameel Y (2008). Effect of probiotic (*Aspergillus niger*) and prebiotic (*Taraxacum officinale*) on blood picture and biochemical properties of broiler chicks. Int. J. Poult. Sci. 7(12): 1182–1184. https://doi.org/10.3923/ijps.2008.1182.1184

Allain C, Poon L, Richmond PC (1974). Enzymatic determination of total serum cholesterol. Clin. Chem., 20(4): 470-475. https://doi.org/10.1093/clinchem/20.4.470

Al-Musodi MF, Hamid MH, Sunah AH (2024). The effect of molasses supplement to drinking water on some productive and Caracas characteristics in broiler chicken. Int. J. Adv. Biochem. Res., 8(9): 38-42. https://doi.org/10.33545/26174693.2024.v8.i9a.2067

Al-Tememe ZM, Hamid MH, Al-Musodi MFH (2025). The effect of the mycotoxins of some fungi isolated from poultry feeds on the relative weight of the liver and gizzard of Broiler chicks in different regions of Karbala, Iraq. Open Vet. J., 15(2): 1050-1055. https://doi.org/10.5455/OVJ.2025.v15.i2.53

Anjorin S, Cyriacus C (2014). Haematological effect of Aspergillus species metabolites on broiler chicks. Am. J. Res. Commun., 2(1): 172-184.

Anwar MI, Khan MZ, Babar A (2001). Effects of dietary formalin on the health and testicular pathology of male Japanese quails (*Coturnix japonica*). Vet. Hum. Toxicol., 43: 330-333.

Atteh JO (2004). Theory and practice of poultry production. ADLEK Printers: Ilorin, Nigeria.

Awais MM, Jamal MA, Akhter M, Ullah MM (2019). Immunomodulatory and ameliorative effects of *Lactobacillus* and *Saccharomyces* based probiotics on pathological effects of eimeriasis in broilers. Microb. Pathog., 126(1): 101-108. https://doi.org/10.1016/j.micpath.2018.10.038

Ayoola MO, Aderemi FA, Alikwe P, Tumgbulu S, Eniufuoma A (2024). Effects of *Eichhornia crassipes* leaf meal as feed additive on performance characteristics and serum biochemistry of broiler birds. J. Anim. Health Prod., 12(2): 249-255. https://doi.org/10.17582/journal.jahp/2024/12.2.249.255

Baker HQ, Hussein SG, Atta MM (2019). Impact of different levels of nigella sativa granules on production, liver enzymes and hormonal characteristics of broiler chickens. Biochem. Cell. Arch., 19(2): 2849-2852.

Basmacioglu H, Oguz H, Ergül M (2005). Effect of dietary esterified glucomannan on performance, serum biochemistry and haematology in broilers exposed to aflatoxin. Czech. J. Anim. Sci., 50: 31-39. https://doi.org/10.17221/3992-CJAS

Betina V (1989). Mycotoxins-chemical, biological and environmental aspects. Amsterdan (NL): Elsevier. Pp. 325-421.

Burtis VC, Ashwood E (1999). Teitz textbook clinical chemistry, 3rd ed. W.B Saunder company, London, UK. pp. 840-843.

Burton R, Harrison J (1969). Relative differential leukocyte count of the newly hatched chicks. Poult. Sci., 48: 451-453. https://doi.org/10.3382/ps.0480451

Campbell TW (1988). Avian hematology and cytology 1st Ed., Iowa State University Press, Amess. Iowa, pp. 5-17.

Canas P, Aranda M (1996). Decontamination and inhibition of patulin induced cytotoxicity. Environ. Toxicol. W. Qual., 11: 249-253. https://doi.org/10.1002/(SICI)1098-2256(1996)11:3<249::AID-TOX10>3.3.CO;2-H

Chawla R (1999). Kidney function test. In: Practical clinical biochemistry: Methods and interpretation. 2nd ed. JAYPEE Brothers Medical Publishers (P) Ltd., New Delhi, India. pp. 90-92.

Che Z, Liu Y, Ding B (2011). The protective effects of different mycotoxin absorbents against blood and liver pathological changes induced by mold- contaminated feed in broilers. J. Anim. Sci., 24: 250-257. https://doi.org/10.5713/ajas.2011.10022

Classen HI, Cooper R (1998). Improving animal feeding through enzyme use. Feed Notes, 1(3). A publication of Praire Feed Resource Centre, Saskatoon, Canada.

Cole R, Richard J (1989). Mycotoxins: Economic and health risks. Council for Agricultural Science and Technology, ed K. A. Nisi, Ames, IA, pp. 1–91.

Fawaz MA, Hassan HA, Wareth AAA (2022). Aflatoxins in poultry feed: Present status and future concerns. SVU Int. J. Agric. Sci., 4(3): 113-124. https://doi.org/10.21608/svuijas.2022.162573.1232

Fossati P, Prencipe L (1982).Serum triglycerides determined with an enzyme that produce hydrogen per oxide clin. Chemistry, 28(16): 2077-2080. https://doi.org/10.1093/clinchem/28.10.2077

Freire RB, Micotoxinas E (1996). In: Perspectiva Latino-americana. Rio de Janeiro: UFRR J. Editora, pp. 261.

Fung F, Clark R (2004). Health effects of mycotoxins: A toxicological overview. J. Toxical Clin. Toxicol., 42: 217-234. https://doi.org/10.1081/CLT-120030947

Ghanim S, Jasim F, Abood HK (2016). Comparative study of serum protein status of local breeds sheep and goats in Basra province. Al-Qadisiyah J. Vet. Med. Sci., 15(2): 16-19.

Girish CK, Devegowda G (2006). Efficacy of glucomannan-containing yeast product (Mycosorb) and hydrated sodium calcium aluminosilicate in preventing the individual and combined toxicity of aflatoxin and T-2 toxin in commercial broilers. Asian-Australas. J. Anim. Sci., 19: 877–883. https://doi.org/10.5713/ajas.2006.877

Hajjaj H, Duboc P, Fay L, Zbinden I, Macé K (2005). *Aspergillus oryzae* produces compounds inhibiting cholesterol biosynthesis downstream of dihydrolanosterol. FEMS Microbiol. Lett., 242: 155–159. https://doi.org/10.1016/j.femsle.2004.11.001

Hao L, Baoan D, Chen L (2020). The effect of *Aspergillus niger* as a dietary supplement on blood parameters, intestinal morphology, and gut microflora in Haidong chicks reared in a high altitude environment. Vet. World, 13(10): 2209-2215. https://doi.org/10.14202/vetworld.2020.2209-2215

Hong KJ, Lee CH, Kim SW (2004). *Aspergillus oryzae* GB-107 fermentation improves nutritional quality of food soybeans and feed soybean meals. J. Med. Food, 7: 430–435. https://doi.org/10.1089/jmf.2004.7.430

Ibrahim AN, Khalefa HS, Hassan Aboul-Ella H, Moubarak V (2021). Efficacy of disinfection on airborne and waterborne fungal load in broiler chicken houses. J. Anim. Health Prod., 9(3): 296-302. https://doi.org/10.17582/journal.jahp/2021/9.3.296.302

Jain N (1986). Veterinary haematology, fourth edition Lea and Febiger, Philadelphia, pp. 1221.

Javed TD, Ombrink-Kurtzman MA, John L (2005). Serohematologic alterations in broiler chicks on feed amended with Fusarium proliferatum culture material or fumonisin B1 and moniliformin. J. Vet. Diagn. Invest., 7: 520–526. https://doi.org/10.1177/104063879500700417

Jeff-Agboola YA (2014). Hematological parameters of broilers fed with feed contaminated with aflatoxin. Br. J. Appl. Sci. Technol., 4(12): 1759-1771. https://doi.org/10.9734/BJAST/2014/4736

Kamalavenkatesh P, Vairamuthu S, Balachandran C, Manohar B, Murali RG, Dhinakar A (2005). Immunopathological effect of the mycotoxins cyclopiazonic acid and T 2 toxin on broiler chicken. Mycopathologia, 159: 273-279. https://doi.org/10.1007/s11046-004-7321-0

Kayode R, Sani A (2008). Physicochemical and proximate composition of mango (*Mangifera indica*) kernel cake fermented with mono-culture of fungal isolates obtained from naturally decomposed mango kernel. Live Sci. J., 5(4): 52-63.

Khaleghipour B, Khosravinia H, Azarfar A (2019). Effects of silymarin on productive performance, liver function and serum biochemical profile in broiler Japanese quail challenged with dietary aflatoxins. Ital. J. Anim. Sci., 18(1): 564-573. https://doi.org/10.1080/1828051X.2018.1548310

Kim SH, Park SY, Lee K (2003). Effects of feeding *Aspergillus oryzae* ferments on performance, intestinal microfloura, blood serum components and environmental factors in broiler. Korean J. Poult. Sci., 30: 151–159.

Kubena LF, Harvey W, Huff WE, Corrier DE, Phlilips TD, Rottinhaus GE (1993). Efficacy of a hydrated sodium calcium aluminosilicate to reduce the toxicity of aflatoxin and T-2 toxin. Poult. Sci., 69: 1078–1086. https://doi.org/10.3382/ps.0691078

Lafi S, Taha N, Al-Genabi S (2010). Histopathology of the liver affected with aflatoxins in broiler chicks. J. Vet. Sci., 3: 115–119.

Liu N, Ding K, Deng Q, Gu K, Wang J (2018a). Effects of lactic acid bacteria and smectite after aflatoxin B1 challenge on the growth performance, nutrient digestibility and blood parameters of broilers. J. Anim. Physiol. Animal Nutr., 102: 953-961. https://doi.org/10.1111/jpn.12901

Liu N, Wang JQ, Gu K (2018b). Effect of cysteamine hydrochloride supplementation on the growth performance, enterotoxic status, and glutathione turnover of broilers fed aflatoxin B1 contaminated diets. Poult. Sci., 97(10): 3594-3600. https://doi.org/10.3382/ps/pey206

Miazzo RC, Rosa EC, De-Queiroz CEC, Magnoli C, Chiacchiera SM, Palacio G, Saenz M (2000). Efficacy of synthetic zeolite to reduce the toxicity of aflatoxin in broiler chicks. Poult. Sci., 79: 1–6. https://doi.org/10.1093/ps/79.1.1

Muhammad NO, Adeyina AO, Apata DV (2000). Nutritional evaluation of fungi treated cocoa bean shell. Niger. J. Pure Appl. Sci., 15: 1059–1064.

Muhammad NO, Oloyede OB (2006). Effects of solid state fermentation on the levels of some nutrients and antinutrients of *Terminalia catappa* seed meal. Niger. J. Biochem. Mol. Biol., 21(2): In Press.

Muhammed N, Oloyede O (2010). Growth performance of broiler chicks fed *Aspergillus niger*- fermented Terminalia catappa seed meal-based diet. Int. J. Biol. Chem. Sci., 4(1): 107-114. https://doi.org/10.4314/ijbcs.v4i1.54236

Nadumane VK, Venkatachalam P, Gajaraj B (2016). Aspergillus applications in cancer research. In: New and future developments in microbial biotechnology and bioengineering, Elsevier: Amsterdam, The Netherlands, ISBN 9780444635136. https://doi.org/10.1016/B978-0-444-63505-1.00020-8

Nagashima T, Tange T, Anazawa H (1999). Dephosphorylation of phytate using the *Aspergillus niger* phytase with a affinity for phytate. Appl. Environ. Microbiol., 65(10): 4682–4684. https://doi.org/10.1128/AEM.65.10.4682-4684.1999

Naseem MN, Noman M, Abbas ZR (2018). Hematological and serum biochemical effects of aflatoxin B1 intoxication in broilers experimentally infected with fowl adenovirus-4 (FAdV-4). Pak. Vet. J., 38(2): 2074-7764. https://doi.org/10.29261/pakvetj/2018.028

Nazarizadeh H, Mohammad A, Pourreza J (2019). Effect of plant extracts derived from thyme and chamomile on the growth performance, gut morphology and immune system of broilers fed aflatoxin B1 and ochratoxin A contaminated diets. Ital. J. Anim. Sci., 18: 1073-1081. https://doi.org/10.1080/1828051X.2019.1615851

Nelson DC, Cox MM (2005). Lehninger principles of biochemistry (4th edn). W.H. Freeman and Co: New York.

Oguz H, Kececi T, Birdane Y (2000). Effect of clinoptilolite on serum haematological character of broiler chickens during aflatoxicosis. Res. Vet. Sci., 67: 89-93. https://doi.org/10.1053/rvsc.2000.0395

Omid V, Mohammad A, Rahimi S (2022). Strain differences in effects of dietary supplementation with *Aspergillus niger* cultures in protein-reduced diets on performance, plasma biochemistry and meat lipid oxidation of broilers. Anim. Prod. Sci., 63(2): 142–151. https://doi.org/10.1071/AN22142

Ozer J, Ratner M, Shaw M (2008). The current state of serum biomarkers of hepatotoxicity. Toxicology, 245: 194–205. https://doi.org/10.1016/j.tox.2007.11.021

Pavlidis HO, Balog JM, Stamps L (2007). Divergent selection for ascites incidence in chickens. Poult. Sci., 86(12): 2517-2529. https://doi.org/10.3382/ps.2007-00134

Piva G, Galvano AA, Pietri APA, Piva RD (1995). Detoxification methods of Aflatoxins. A review. Nutr. Res., 15: 767–776. https://doi.org/10.1016/0271-5317(95)00042-H

Rodkey FL (1965). Direct spectrophotometric determination of albumin in human serum. Clin. Chem., 11(4): 478-487. https://doi.org/10.1093/clinchem/11.4.478

Salah M, Al-Tememe ZM, Al-Musodi MF (2025). Study of the relative weight of some cuts for broiler ROSS 308 which mycotoxin treatment for the fungi *Aspergillus flavus* and *Aspergillus niger*. J. Res. Vet. Sci., 5(2): 1-6. https://doi.org/10.5455/JRVS.20250403041054

Saleh AA, Eid YZ, Ebeid T (2011). Effects of feeding *Aspergillus awamori* and *Aspergillus niger* on growth performance and meat quality in broiler chickens. J. Poult. Sci., 48: 201–206. https://doi.org/10.2141/jpsa.011019

Saleh AA, Gálik B, Arpášová, Ohtsuka A (2017). Synergistic effect of feeding *Aspergillus awamori* and lactic acid bacteria on performance, egg traits, egg yolk cholesterol and fatty acid profile in laying hens. Ital. J. Anim. Sci., 16: 132–139. https://doi.org/10.1080/1828051X.2016.1269300

Soares LMV, Rodriguez-Amaya DB (1989). Survey of aflatoxins, ochratoxins, zearalenone and sterigmatocystin in some Brazilian foods by using multi-toxin thin layer chromatographic method. J. Assoc. Off. Anal. Chem., 72: 22–26. https://doi.org/10.1093/jaoac/72.1.22

Solis-Cruz B, Hernandez-Patlan D, Petrone VM (2019). Evaluation of a Bacillus-based direct-fed microbial on aflatoxin B1 toxic effects, performance, immunologic status, and serum biochemical parameters in broiler chickens. Avian Dis., 63: 659-669. https://doi.org/10.1637/aviandiseases-D-19-00100

Srinivasan N, Thangavelu A, Uthandi S (2022). Lovastatin production by an oleaginous fungus, Aspergillus terreus KPR12 using sago processing wastewater (SWW). Microbial Cell Factor., 21: 22. https://doi.org/10.1186/s12934-022-01751-2

Statistical Anaylsis System (SAS) (2010). User guide for personal computers. SAS. Institute Inc. Cam, N.C., USA.

Tang SGH, Sieo CC, Ramasamy K (2017). Performance, biochemical and haematological responses, and relative organ weights of laying hens fed diets supplemented with prebiotic, probiotic and synbiotic. BMC Vet. Res., 13(1): 248. https://doi.org/10.1186/s12917-017-1160-y

Tarrago J, Puchal F (1977). Effect of strain, sex and stocking on performance and carcass yield of caged broiler. Br. Poult. Sci., 18: 95-99. https://doi.org/10.1080/00071667708416333

Tietz NW (1995). Clinical guide to laboratory tests, 3rd W.B., Saunder company Philadelphia, USA, pp. 266-273.

Tufan T, Bolacali M (2017). Effects of dietary addition of synbiotic on the performance, carcass traits, and serum parameters of Japanese quails. Rev. Brasil. Zoot. 46: 805–813. https://doi.org/10.1590/s1806-92902017001000003

Ukoha OA, Onwudike OC, Onabanjo RS (2022). Effects of African nutmeg spice in *Aspergillus flavus* infected diets on nutrient digestibility, haematology and blood chemistry of broiler chickens. Nig. J. Anim. Prod., 49(4): 97-105.

Varely AH, Bell M (1980). Practical clinical biochemistry, 5th Ed. London, William Heinemann medical book, Ltd. pp. 107-122.

Wootton IDP (1964). Micro analysis in medical biochemistry 4th Ed. J and A. Churchili Ltd. London, pp. 71-73.

Wroblewski F, Ladue J (1956). Serum glutamic pyruvic transaminase in cardiac and hepatic disease. Proc. Soc. Exp. Biol. Med., 91(4): 569-571. https://doi.org/10.3181/00379727-91-22330

Yunus AW, Razzazi-Fazeli E, Bohm J (2011). Aflatoxin B1 in affecting broiler's performance, immunity, and gastrointestinal tract: a review of history and contemporary issues. Toxins (Basel), 3: 566–590. https://doi.org/10.3390/toxins3060566

Zou Y, Liu S, Zhang A, Ze-tan A (2023). Effects of Aflatoxin B1 on growth performance, carcass traits, organ index, blood biochemistry and oxidative status in Chinese yellow chickens. J. Vet. Med. Sci., 85(9): 1015–1022. https://doi.org/10.1292/jvms.23-0130