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Effect of *Moringa Oleifera* Leaves on Biochemical Parameters, and Production Performance of Turkey

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ABSTRACT

A recent experimental study was conducted to evaluate the effects of dietary inclusion of *Moringa oleifera* leaf meal on hematological parameters, blood biochemical indices, and productive performance in female turkey poults (*Meleagris gallopavo*). A total of 36 clinically healthy turkey hens, aged 26 weeks, were acquired and reared under controlled environmental and managerial conditions throughout the study period. The birds were randomly allocated into four dietary treatment groups: Group A (control, 0% *Moringa oleifera*), Group B (1% inclusion), Group C (1.5%), and Group D (2%), with three replicates per treatment and three birds per replicate. Hematological parameters evaluated included red blood cell count (RBC), hemoglobin concentration (Hb), packed cell volume (PCV), and total and differential leukocyte counts. Blood biochemical indices such as total protein, albumin, globulin, glucose, cholesterol, and liver enzyme activities (ALT and AST) were also measured. Productive performance indicators—live body weight, weight gain, feed intake, and feed conversion ratio (FCR)—were monitored throughout the trial. Data were statistically analyzed using one-way ANOVA, followed by Duncan's multiple range test to determine significant differences ($p < 0.05$) among treatment means. The results demonstrated that dietary supplementation with *Moringa oleifera* leaf meal significantly improved several hematological and biochemical parameters, indicating enhanced physiological status and immune competence. Moreover, the inclusion of *Moringa oleifera* leaf meal positively affected growth performance, with Group D (2% *Moringa oleifera*) showing the most favorable outcomes across all production traits. In conclusion, the study suggests that *Moringa oleifera* leaf meal, at an inclusion level of up to 2%, can serve as a natural feed additive with potential health-promoting and growth-enhancing benefits in turkey hens, offering a promising alternative to conventional performance enhancers in poultry production.

تأثير أوراق المورينجا أوليفيرا على بعض الصفات الفسلجية والاداء الانتاجي لطائر الديك الرومي

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الخلاصة :

أجريت دراسة تجريبية حديثة لتقييم آثار التضمين الغذائي لوجبة أوراق المورينجا على الصفات الفسلجية والأداء الإنتاجي في قطعان الديك الرومي. تم الحصول على ما مجموعه 36 دجاجة ديك رومي بعمر 26 أسبوعا ، تم توزيع الطيور بشكل عشوائي على أربع مجموعات علاجية غذائية: المجموعة أ (السيطرة ، 0 ٪ *Moringa oleifera*) ، المجموعة ب (1 ٪ *Moringa oleifera*) ، المجموعة ج (1.5٪) ، والمجموعة د (2٪) ، وشملت الصفات الفسلجية تقييم عدد خلايا الدم الحمراء ، وتركيز الهيموغلوبين وحجم الخلايا معبأة ، وعدد كريات دم البيض الكلي. كما تم قياس مؤشرات الكيمياء الحيوية في الدم مثل البروتين الكلي ، والألبومين ، والكلوبيولين ، والكلوكوز ، والكوليسترول ، ونشاط إنزيمات الكبد ، اشارت البيانات تحسن معنوي في الصفات الانتاجية. أظهرت النتائج أن المكملات الغذائية مع وجبة أوراق المورينجا تحسن بشكل كبير لصفات الدم الخلوية مما يشير إلى تعزيز الحالة الفسيولوجية والكفاءة المناعية. وجد ان اضافة النبات قد اعطت تاثير معنوي وبشكل إيجابي على أداء النمو ، حيث أظهرت المجموعة د (2 ٪) النتائج الأكثر ملاءمة في جميع صالصفات الانتاجية. تشير الدراسة إلى أن إضافة أوراق المورينجا عند مستوى احتواء يصل إلى 2 ٪ بمثابة مادة مضافة للأعلاف الطبيعية مع فوائد محتملة لتعزيز الصحة والنمو في الدجاج مما يوفر بديلا واعدا لمحسنات الأداء التقليدية في إنتاج الدواجن.

الكلمات المفتاحية: اداء انتاجي، اوراق المورينجا ، دجاج.

INTRODUCTION

Feed additives used as growth promoters play a pivotal role in enhancing the economic efficiency of modern poultry production, offering considerable advantages to both producers and consumers of animal-derived products (Castillo *et al*., 2018). Among these additives, *Moringa oleifera*, a species belonging to the Moringaceae family and widely distributed across tropical and subtropical regions (Edu *et al*., 2019), has shown promising potential in poultry nutrition due to its high content of essential amino acids, antioxidants, and lipids (Mbikay, 2012).

Moringa oleifera is particularly valued for its potent antioxidant properties, which are attributed to the presence of vitamin C, vitamin E, carotenoids, flavonoids, and selenium (Moyo *et al*., 2016). In addition, it can be effectively incorporated into livestock diets to enhance both the availability and quality of nutrients (Anhwange *et al*., 2004). The leaf meal of *Moringa oleifera* is recognized as a rich source of nutrients for poultry and has been identified as an excellent protein supplement (Keamogetswe *et al*., 2022; Compaoré *et al*., 2011). Several studies have documented the efficacy of *Moringa oleifera* as a natural growth promoter, reporting significant improvements in body weight and weight gain in broiler chickens (Zanu *et al*., 2012; Nkukwana *et al*., 2014). Moreover, investigations by Onu and Aniebo (2011), as well as Onunkwo and George (2015), revealed that dietary inclusion of *Moringa oleifera* in broiler feed improved feed efficiency and growth performance.

In light of these demonstrated nutritional and physiological benefits, the present study aims to investigate the effects of *Moringa oleifera* leaves on the physiological and productive traits of turkey birds.

MATERIALS AND METHODS

Experiment management.

This research was conducted at the Tikrit Research Department of the Agricultural Research Directorate under controlled conditions. Temperature and humidity were carefully regulated throughout the experiment. The experiment was conducted in April 2024 for a duration of four weeks, during which all birds were raised under similar environmental conditions. A total of 36 turkey birds, 26 weeks old, were obtained and reared for the experiment. The birds were randomly assigned to four treatment groups, with three birds housed per cage. They were fed a commercial diet and distributed as follows:

Group A (Control): 0% *Moringa oleifera*

Group B, C, and D Supplementation with 1, 1.5, and 2.0%. (*Moringa oleifera*)

The Leaf samples of *Moringa oleifera* were carefully collected and separated from the stems. The plant material was obtained from local markets. The leaves were washed with tap water and air-dried in the shade until completely dehydrated, then ground into a fine powder. The powder was subsequently stored in plastic bags under controlled temperature and humidity conditions until used in the experiment.

Birds Parameters

The body weight of each bird was recorded at the end of each week to determine the average body weight and weight gain for the different treatment groups. Weight gain was calculated as the difference between two successive weekly body weights using the following formula: Weight gain = Final weight – Initial weight; feed intake measured weekly by weighing the feed to determine the average feed intake for each treatment groups. The Feed conversion ratio (FCR) was calculated by dividing the total feed intake (in gram) by the total body weight gained (in gram), as shown in the formula below:

$$\text{FCR} = \frac{\text{Average feed intake (g)}}{\text{Average weight gain(g)}}$$

Blood samples were collected from the wing vein at the end of the experiment (after 4 weeks) using two types of tubes: one containing an anticoagulant and the other without. Hematological parameters, including red blood cell (RBC) count, packed cell volume (PCV), and hemoglobin concentration (Hb), were assessed following the method described by Campbell (1995). Serum was separated from the non-anticoagulated blood samples by centrifugation at 3000 rpm for 20 minutes and stored at –20°C until analysis.

Blood parameters were measured using a biochemical analyzer with commercial kits. Serum samples were analyzed for cholesterol, aspartate aminotransferase (AST), alanine aminotransferase (ALT), total protein, albumin, and triglycerides.

Table 1: Ingredients and chemical composition of the basal diet used in the experiment.

Ingredient	Percentage (%)
Yellow maize	42%
Wheat	35%
Soybean meal (44%)	14%
Vegetable oil	3%
Limestone	2%
Salt	1%
Di calcium phosphate	3%
Total	**100 %**
Chemical composition	
Parameter	**Value**
Crude protein (Cp%)	13.75
Metabolizable Energy kcal/kg	3051.2
Lysine (%)	0.59
Methionine (%)	0.21

Data analysis

A completely randomized design was used for analysis with Statistical Analysis Software (SAS, 2010). Duncan's test (Duncan, 1955) was applied to determine the significance of differences in factor means for the studied traits at the probability level ($p \leq 0.05$).

RESULTS AND DISCUSSION

Table 2 presents the live body weight and weight gain for each treatment group in the experiment. Significant differences were observed among birds fed diets supplemented with *Moringa oleifera*. The highest weight gain was recorded during the third week of the experiment, particularly in Group D (2.0% *Moringa oleifera*), which achieved an average body weight of 4650.30 g after three weeks and 4832.37 g after four weeks. Group C (1.5% *Moringa oleifera*) followed, with an average body weight of 4565.87 g at week 3 and 4710.48 g at week 4.

Table 2: The effect of *Moringa oleifera on* body weight and body weight gain traits.

Treatment	starting weight	BODY WEIGHT (g)			
		AGE			
		1 WEEK	2 WEEK	3 WEEK	4 WEEK
A	4320	4385±120.12	4455.33±167.23	b4543.34±78.83	c4666.25±67.12
B	4312	4390±111.04	4490.23±105.12	a4592.77±45.32	b4723.67±87.45
C	4293	4365±78.45	4477.64±84.11	a4630.15±94.14	b4782.12±58.38
D	4288	4358±137.34	4481.00±56.34	a4650.30±89.21	a4832.37±70.56
Treatment		BODY WEIGHT GAIN (g)			
A	4320	65.00±2.25	c 70.00±6.22	c88.47±7.73	d 123.47±10.21
B	4312	78.00±4.33	b100.23±7.13	b102.27±7.56	c 131.46±9.34
C	4293	72.00±3.77	b112.15±5.43	a153.65±10.43	b152.87±11.33
D	4288	70.00±2,44	a123.56±8.23	a169.00±9.67	a 182.33±13.76

• a, b, c In each column, means with different superscripts are significantly different ($p<0.05$).

• A: control group B, C, D supplemented with *Moringa oleifera diet* 1.0%,1.5%,2.0%, respectively

Although the control group recorded the lowest values for body weight and weight gain, the increases observed in the treated groups may indicate a positive effect of *Moringa oleifera* supplementation on the birds. *Moringa oleifera* leaves are considered a valuable feed supplement for poultry, contributing to improved health and growth performance (Ogbe and John, 2011 and Khtab, *et al*. (2023).

These improvements in body weight suggest enhanced growth rates, which may be attributed to the high protein content of Moringa. The findings of this experiment are consistent with previous studies, such as those reported by Onunkwo and George. (2015). Significant increases in body weight were also observed in broilers when *Moringa oleifera* was included in their diet, as reported by Alnidawi *et al*. (2016). They investigated *Moringa oleifera*supplementation at 1.0%, 1.5%, and 2.0% levels in broiler feed and found a significant effect on body weight, particularly at the 2.0% level. These results are also consistent with the findings of David *et al*. (2012), who reported that supplementing broiler diets with 5% *Moringa oleifera* powder had a notable positive effect on growth performance.

The results presented in Table 3 show the feed consumption rate and feed conversion ratio (FCR) throughout the experiment. Significant differences were observed among the treatment groups, with Group D exhibiting a notable improvement in feed intake. This improvement indicates the positive effect of *Moringa oleifera* supplementation on feed consumption and utilization efficiency.

Table 3: The Effect of *Moringa oleifera on* Feed Intake and Feed Conversion Ratio (FCR) traits

Feed intake (gram/ bird)					
treatment	starting weight	Age			
		1 week	2 week	3 week	4 week
A	4320	275.12 ±10.05	278.33 ±11.54	371.54 ±19.23	b385.16 ±9.65
B	4312	277.33 ±9.34	267.22 ±14.46	317.34 ±21.44	a418.46 ±10.43
C	4293	270.32 ±7.78	281.33 ±17.54	327.00 ±16.27	a433.68 ±8.64
D	4288	259.46 ±8.81	288.33 ±12.76	365.11 ±18.56	a451.57 ±7.89
treatment		Feed conversion ratio (FCR)			
A	4320	a4.23 ±0.1	a3.98 ±0.2	a4.220 ±	a3.13
B	4312	b3.56 ±0.06	b2.67 ±0.09	b3.11 ±	a3.19
C	4293	b3.75 ±0.04	b2.51 ±0.06	c2.14 ±	ab2.85
D	4288	b3.70 ±0.09	b2.34 ±0.05	c2.16 ±	b2.48

• a, b, c In each column, means with different superscripts are significantly different ($p<0.05$).
• A: control group B, C, D supplemented with *Moringa oleifera diet* 1.0%,1.5%,2.0%, respectively

Additionally, a significant improvement in the feed conversion ratio (FCR) was recorded in the groups treated with *Moringa oleifera*. This improvement was associated with higher inclusion levels of *Moringa oleifera* in the diet, which positively influenced feed intake. These findings confirm its role in stimulating birds' appetite and enhancing their ability to utilize nutrients more efficiently. A notable enhancement in FCR further supports the beneficial impact of *Moringa oleifera* on poultry performance. Our findings are in line with those of Gakuya *et al*. (2014), who reported an increase in the average total feed intake when *Moringa oleifera* was added to the diet of layer chickens. Similarly, David *et al*. (2012) found that supplementing poultry diets

with *Moringa oleifera* leaf powder enhanced bird health, improved live weight, increased body weight gain, boosted feed intake, and optimized FCR.

The results of the blood analysis are presented in Table 4. These findings indicate that feeding turkey hens with *Moringa oleifera* leaf meal led to a significant increase in red blood cell (RBC) count, packed cell volume (PCV), and hemoglobin (Hb) levels across all dietary inclusion levels.

Table 4: shows the effect of *Moringa oleifera* supplementation on some hematological traits in turkey

Treatment	RBC (X106/µl)**	Hb (g/100ml)	PCV%
A	b2.33±0.04	c10.34±0.6	c31.25±0.9
B	a3.19±0.01	b12.52±0.4	b33.91±1.01
C	a3.61±0.02	b12.35±0.8	b34.27±0.6
D	a3.12±0.03	a13.14±0.7	a35.07±0.3

• a, b, c In each column, means with different superscripts are significantly different ($p<0.05$).
• A: control group B,C,D supplemented with *Moringa oleifera diet* 1.0%,1,5% ,2.0% respectively.

Moringa oleifera leaves contain a variety of bioactive compounds, such as carotenoids, flavonoids, chlorophyll, phenolics, xanthins, cytokines, and alkaloids, which may contribute to improved health status in poultry (Falowo *et al*., 2014). These bioactive components may play a role in enhancing the physiological condition of birds, leading to an increase in red blood cell (RBC) count. Our results are consistent with the findings of Alnidawi *et al*. (2016), who reported increased RBC count and hemoglobin (Hb) levels when *Moringa oleifera* leaves were included in broiler diets at 0%, 5%, 10%, 15%, and 20% levels from day 0 to day 42 of the experiment. Similarly, Gadzirayi *et al*. (2012) observed significant increases in RBC, packed cell volume (PCV), and Hb levels when *Moringa oleifera* leaves were added to broiler diets at various inclusion levels.

Table 5 presents the effect of *Moringa oleifera* supplementation on selected blood biochemical parameters in turkey hens. The results of the experiment demonstrated that triglyceride and cholesterol levels were significantly lower in turkey hens fed diets supplemented with Moringa. Additionally, *Moringa oleifera*supplementation exhibited a positive effect by reducing the activity of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) enzymes, indicating hepatoprotective properties.

Table 5: The effect *of Moringa oleifera* on some biochemical parameters in turkey

Treatment	Triglyceride (mg/100ml)	Cholesterol (mg/100ml)	AST IU/l)	ALT IU/l)	Total Protein g/dl	Albumin g/dl
A	a90.54±10.23	a167.24±7.78	a154.41±8.11	a10.85±0.05	b4.88±0.16	b3.19±0.2
B	b77.75±8.78	b147.66±5.45	ab151.05±3.32	b8.15±0.07	ab5.06±0.1	a4.40±0.1
C	b76.26±3.70	b149.56±7.14	b143.11±6.56	bc7.72±0.20	a6.35±0.3	a4.91±0.09
D	c71.30±5.63	b148.78±6.69	b141.41±5.78	c6.16±.0.10	a6.79±0.1	a4.65±0.2

• a, b, c In each column, means with different superscripts are significantly different ($p<0.05$).
• A: control group B,C,D supplemented with *Moringa oleifera diet* 1.0%,1,5% ,2.0% respectively.

*Moringa oleifera*leaves may play a role in lowering cholesterol levels by enhancing lipid metabolism in the host body (Mahfuz and Piao, 2019). The hypolipidemic effect of *Moringa*

*oleifera*is likely attributed to its rich antioxidant content, particularly flavonoids and carotenoids, along with its high fiber content, which contributes to cholesterol reduction. This finding is further supported by Ahmad *et al*. (2017). The findings of the present study align with previous research, such as AbouSekken (2015), which reported a significant reduction in cholesterol levels in broiler chickens following *Moringa oleifera* supplementation at different inclusion rates. Similarly, Ahmad *et al*. (2017) reported comparable results. Overall, these results suggest that *Moringa oleifera* supplementation can positively modulate lipid metabolism and liver enzyme activity, reinforcing its potential application as a functional feed additive in poultry nutrition. A lower level of serum cholesterol was also observed in commercial layers receiving dietary supplementation with Moringa. These results are consistent with the findings of Djouhou *et al*. (2020), who reported that the consumption of *Moringa oleifera* leaves leads to a significant decrease in AST and ALT activities.

Regarding plasma total protein in the current experiment (Table 5), the addition of *Moringa oleifera*as a feed additive led to a significant increase in total protein levels, along with an increase in albumin concentration in the blood serum. This trend was observed in all Moringa-treated groups. These results were confirmed by Djouhou *et al*. (2020), who found that consumption of *Moringa oleifera* leaf powder by birds significantly increased protein synthesis. Our findings also agree with Samarth *et al*. (2003), who reported that incorporating *Moringa oleifera* leaf into broiler feed led to an increase in serum protein content. Moreover, our results align with those of Voemesse *et al*. (2019), who found that albumin levels increased significantly ($p < 0.05$) in layer birds fed with 3% *Moringa oleifera* leaves. Furthermore, all these findings serve as a good indicator of the liver's synthetic function.

CONCLUSION

Based on the results of this study, it can be concluded that the addition of *Moringa oleifera* leaves to the turkey diet exerts significant positive effects on various health and performance parameters. The results demonstrated considerable improvements in body weight and weight gain across all groups supplemented with Moringa, with the most pronounced effects observed in the group receiving 2.0% *Moringa oleifera*supplementation. Additionally, feed intake and feed conversion ratio (FCR) were improved, indicating enhanced efficiency in nutrient utilization.

Furthermore, *Moringa oleifera*supplementation positively influenced key hematological parameters, including increased red blood cell (RBC) count, hemoglobin (Hb) concentration, and packed cell volume (PCV). Significant reductions in triglyceride and cholesterol levels were also noted, along with beneficial effects on liver enzyme activities (AST and ALT), reflecting hepatoprotective properties.

Based on these findings, *Moringa oleifera* leaves are recommended as an effective functional feed additive to enhance both productive performance and health status in poultry.

Recommendations for Future Research.

Further studies are recommended to evaluate the effects of *Moringa oleifera* leaves at a wider range of inclusion levels beyond those examined in the present study. Additionally, investigating the impact of *Moringa oleifera*supplementation on various poultry species, including broilers, layers, quails, and ducks, would provide broader insights into its potential benefits and optimal

application. Moreover, exploring the long-term effects and elucidating the underlying mechanisms of Moringa's bioactive compounds across different avian species would contribute valuable knowledge to better understand its functional roles in poultry nutrition and health management.

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