SINAI Journal of Applied Sciences 12 (4) 2023 639-654

Available online at www.sinjas.journals.ekb.eg

SCREENED BY SINAI Journal of Applied Sciences

Print ISSN 2314-6079
Online ISSN 2682-3527

THE IMPACT OF USING DEHYDRATED *Moringa oleifera* LEAVES ON THE GROWTH PERFORMANCE, CARCASS, AND BLOOD PARAMETERS OF BROILER CHICK

Aya G. Abed*; M.A. Abdel Ghaffar; K.S. Ahmed and A.M. Ali

Dept. Ani. and Poult. Prod., Fac. Environ. Agric. Sci., Arish Univ., Egypt.

ARTICLE INFO

Article history:
Received: 29/07/2023
Revised: 03/08/2023
Accepted: 06/08/2023

Keywords:
Chicks,
Moringa oleifera leaves,
productive performance,
poultry feed.

ABSTRACT

The study aimed to investigate the potential advantages of incorporating *Moringa olifera* leaves (MOLM) into broiler diets as a feed replacement of soyabean meal. A total number of 120 7-day-old Ross chicks were selected for the study. The birds were randomly divided into four treatment groups, each with 30 birds and three replicates with 10 chicks each, and fed on diets containing four levels of *Moringa oleifera* leaves 0, 2, 3, and 5% were substituted from soyabean meal). Growth performance, carcass traits, digestibility coefficient, some blood analyses, and economic efficiency were recorded. The results showed that, birds fed diet contained MOLM during starter and grower period, respectively recorded significantly (P≤0.05) the best body weight, body weight gain and feed conversion ratio compared with control diet. The results showed that the diet of *Moringa oleifera* leaves did not affect the digestion coefficient (%) of growing broilers. Except for the increase in nitrogen balance (NB%) with the addition of MOLM to diet. The findings demonstrated that dietary amounts of *Moringa oleifera* had no impact on the carcass characteristics of developing broilers. Also, on biochemical parameters, the findings revealed no statistically significant variation among the various treatments. Except for glucose, low density lipoprotein (LDL), and alanine transaminase (ALT), there were significant differences depending on the level of MOLM in the diet. Finally, these results suggest that including 3-5% *Moringa oliefera* leaves in the chick, feed can lead to higher economic efficiency and net revenue compared to not including it.

INTRODUCTION

Poultry farming plays an important role in meeting the rising need for meat and egg products. However, feed costs significantly affect the profitability of chicken farming. As a result, farmers prioritize finding cost-effective alternative feed sources **El-Kashef *et al.*, 2017; Yousha *et al.*, 2020 a and b)**. *Moringa* leaves (ML) have been proposed as a viable feed supplement for chickens due to their rich nutrient profile, which includes protein, vitamins, and minerals (**El-Kashef *et al.*, 2017; Jiya *et al.*, 2020**).

Moringa oleifera is a plant that originates from the Indian subcontinent and has been recognized for its medicinal and dietary properties for a long time. *Moringa oleifera* contain a variety of essential nutrients such as protein, vitamins A and C, as well as minerals like calcium and iron. Recently, researchers have investigated the utilization of *Moringa oleifera* as a supplementary feed source for poultry (**El-Kashef *et al.*, 2017; Khan *et al.*, 2017**).

Although *Moringa oleifera* has shown promise as a feed supplement for chickens, the optimal proportion of *Moringa oleifera* in the feed and any potential risks associated

* **Corresponding author: E-mail address:** aya076540@gmail.com
https://doi.org/ 10.21608/sinjas.2023.225888.1220

with its use remain unclear and require further investigation. Thus, the objective of this study was to investigate the impact of incorporating MOLM into chicken diets and assess its potential advantages and disadvantages on growth performance.

MATERIALS AND METHODS

The study was conducted at the Department of Animal and Poultry Production Research Farm, which is a component of Arish University in North Sinai, Egypt's Faculty of Environmental Agricultural Sciences. A total number of 120 one-day-old Ross chicks were chosen for the study and acclimatized on the experimental site for seven days. The birds were incubated and fed on a baseline diet for a week to acclimatize and after this week distributed randomly into four treatment groups, each consisting of 30 birds, with three replicates of 10 chicks per replicate. Throughout the trial, the chicks were kept under the same management and hygienic conditions.

The experimental diets that were designed to meet the recommended nutrient requirements of the Ross breed (Tables 1 and 2). The diets were made iso-nitrogenous and iso-energetic based on guidelines from the **NRC (1996)**. The chicks were then divided into four dietary treatments based on these diets. Tr1 (as control), Tr2 (control plus 2% MOLM), Tr3 (control plus 3% MOLM), Tr4 (control plus 5 % MOLM as a feed replacement of soyabean).

Various performance variables were measured during the experiment. These variables included initial and final body weight, body weight gain, total feed intake, and feed conversion. The body weight and feed intake were recorded weekly to calculate body weight gain using a formula that subtracted the initial weight from the final weight. The feed conversion ratio (FCR) was also calculated using the amount of feed consumed divided by the weight gained.

After the 35-day trial, 9 birds per treatment, overall, which included (3) birds from each replicate, underwent an 8-hour feed deprivation period. Following this period, the birds were weighed and slaughtered to determine certain carcass characteristics, such as the carcass itself, as well as the head, liver, heart, gizzard, and giblets.

Blood samples were collected and analyzed using commercial kits to measure the serum levels of various components including total protein, albumin, globulin, glucose, total lipids, low density lipoprotein (LDL), high density lipoprotein (HDL), cholesterol, and liver enzymatic activity aspartate transaminase (AST) and alanine transaminase (ALT). To calculate the globulin value, the albumin value was subtracted from the total protein value. Furthermore, the albumin and globulin data were used to determine the albumin/ globulin ratio (A/G).

Fecal nitrogen was determined following the procedure out lined by **Jakobsen *et al.* (1960)**.

After the birds reached 35 days of age, 4 digestibility trials were conducted. Each trial involved nine male birds that were housed in individual cages. The birds were fed the experimental diets for three days to allow them to adjust to the new environment.

Chemical analyses were performed on the examined diets and excreta using **AOAC (2000)** procedures for dry matter, ash, crude protein, ether extract, crude fiber, and nitrogen-free extract.

The collection period extended to five days in which excreta were quantitavly collected every 24 hours and daily intake was recorded.

The excreta was cleaned from feathers and leed then weighted and dried in an oven at 60^{o}C for 36 hours. Samples were then finally ground and placed in screw - top glasses until analysis.

For the economic evaluation of the feed, the current market prices of the ingredients and *Moringa oleifera* plant utilized throughout the study period were employed. Economic efficiency is defined as the net revenue per unit feed cost computed from input-output analysis.

E.E= Net revenue/Price of feed to produce one kg Live Body Weight.

Statistical Analysis

The statistical analysis for the study was performed using a one-way analysis of variance (ANOVA), as specified in the SAS program **(SAS, 2004)**. To identify significant differences between treatment means, Duncan's Multiple Range Test **(Duncan, 1955)** was employed. $P < 0.05$ was used as the significance level for all statistical tests. This means that any results with a p-value less than 0.05 were deemed statistically significant and any results with a p-value greater than or equal to 0.05 were not considered significant.

The ANOVA models used were

$$Yij = \mu + Ti + Eij$$

Were:

Yij = the observation of ij.

μ = the overall mean.

Ti = the effect of treatments.

Eij = the experimental randomly error.

RESULTS AND DISCUSSION

Chemical Composition on Dry Matter of *Moringa oleifera* leaves (%)

A study found that while crude fiber was 17%, ash and Nitrogen Free Extract in leaves was 23.9%, while the proportion of protein was 28 and the percentage of fat was 10.6. Moisture percentage was 8.5.

According to **Mabruk *et al.* (2010)**, the nutritional composition of *Moringa oleifera* leaves (DM, Ash, CP, EE, CF) and their digestibility (g/kg) were 930.0, 138.9, 267.9, 64.0, and 790.5, respectively.

Dye and De (2013) found that the Dry Matter of *Moringa oleifera* leaves meal (MOLM) was 93.6, as well as lower percentages of ash (7.9), CP(22.2), CF (6.7), EE (6.4), and NFE (40.2). Gross energy was (14.7) (MJ/kg). These results suggest that the nutritional composition of MOLM changes with location and may be with the leaf harvesting stage.

Growth Performance

Starter period (7-21 days)

There was little difference among the control and the other treatments throughout the first stage of the *Moringa oleifera* leaves meal (MOLM) dietary feeding effect on live body weight and body weight gain increase from 7 to 21 days of age. According to feed intake, the addition of MOLM had significant effects on feed intake, at all three-time intervals; the feed intake of the chicks feed on the MOLM-containing diets was greater than that of the control diet, and with the diet containing 5% MOLM having the maximum feed consumption. Additionally, it appeared that depending on the amount of MOLM in the diet and the measurement window, the effects of MOLM on feed intake varied (Table 4).

For example, at days 7–14, the chicks fed on the 3% MOLM diet consumed the most feed, while at days 14–21 and 7–21, the chicks fed on the diet that included 5% MOLM consumed the most feed. While the feed conversion ratio, in accordance with the results of the study, there was no statistically significant difference ($P \geq 0.05$) among the control group and the diet with MOLM during 14–21 days and 7–21 days of age. According to **Atuahene *et al.* (2010)** the body weight gain and feed intake of broiler chicks were not significantly impacted by diets containing *Moringa leaf* meal at levels of 0, 2.5, 5, and 7.5%.

Table 1. Composition and chemical analysis of starter diets (7-21days)

Ingredient (%)	T1	T2	T3	T4
Yellow Corn, ground	59.91	59.51	58.51	58.01
Soybean meal (48%cp)	31.9	29.9	28.9	26.9
Corn gluten meal (60%cp)	3.6	4	5	5.5
MOLM	0	2	3	5
Limestone	2.1	2.1	2.1	2.1
Di-calcium phosphate(Di-Ca-P)	1.29	1.29	1.29	1.29
Premix*	0.2	0.2	0.2	0.2
Salt	0.3	0.3	0.3	0.3
DL-Methionine	0.1	0.1	0.1	0.1
L-Lysine	0.6	0.6	0.6	0.6
Total	**100**	**100**	**100**	**100**
Calculated analysis				
ME, Kcal/Kg	2919	2930	2922	2901
CP (%)	23.2	23	23.3	23.3
CF (%)	3	3.3	3.3	3.3
EE (%)	2.8	2.8	3.8	3.8
Ca (%)	1	1	1	1
Avail. P (%)	0.4	0.4	0.4	0.4
Lys. (%)	1.1	1.1	1.1	1.1
Meth. (%)	0.6	0.4	0.4	0.4
Determine analysis				
Protein	22.8	22.8	22.9	22.9
Ether extract	3.0	3.1	3.4	3.6
Crude fiber	2.2	2.7	2.7	2.8
Ash	4.6	4.3	5.0	4.8
Moisture	10.8	10.1	10.3	10.0
OM	95.4	95.6	95.0	95.1
NEF	56.5	56.8	55.6	55.9
Metabolizable energy (ME)ENRGY k/100g	344	345	345	348
DM	89.1	89.8	89.6	90.0

* The premix (Vitam. and Min.) was included at an amount of three kilograms per ton of diet and each kilogram of the premix delivered the following in mg or I.U. : vitamin A 12,000 IU, vitamin D3 2000 IU, vitamin E 40 mg, vitamin K3 4 mg, vitamin B1 3 mg, vitamin B2 6 mg, vitamin B6 4 mg, vitamin B12 0.03 mg, pantothenic acid 12 mg, folic acid 1.5 mg, chloride 700 mg, mn 80 mg, copper 10 mg, se. 0.2 mg, iron 0.4 mg, fe. 40 mg, zinc 70 mg, and co. 0.25 m.

Table 2. Composition and chemicals analysis of grower diets (21-35days)

Ingredient (%)	T1	T2	T3	T4
Yellow Corn, ground	70.55	69.95	69.85	68.95
Soybean meal (48%cp)	20	18	17	15
Corn gluten meal (60%cp)	5	6	6.1	7
MOLM	0	2	3	5
Limestone	1.48	1.48	1.48	1.48
Di-calcium phosphate(Di-Ca-P)	2	1.6	1.6	1.6
Premix*	0.3	0.3	0.3	0.3
Limestone	0.3	0.3	0.3	0.3
DL-Methionine	0.15	0.15	0.15	0.15
L-Lysine	0.22	0.22	0.22	0.22
Total	**100**	**100**	**100**	**100**
Calculated analysis				
ME, Kcal/Kg	3052	3047	3036	3017
CP (%)	19.1	19.2	19.1	19.1
CF (%)	3.3	3.3	3.3	3.3
EE (%)	2.9	2.9	2.9	2.9
Ca (%)	0.9	0.9	0.9	0.9
Avail. P (%)	0.5	0.4	0.4	0.4
Lys. (%)	0.8	0.8	0.8	0.8
Meth. (%)	0.5	0.5	0.5	0.5
Determine analysis				
Protein	18.8	19.6	19.6	19.5
Ether extract	4.3	4.4	4.0	4.3
Crude fiber	2.7	2.5	2.6	2.6
Ash	4.8	4.2	4.6	5.1
Moisture	9.9	10.2	9.8	9.9
OM	95.2	95.7	95.3	94.9
NEF	59.4	58.9	59.2	58.5
Metabolizable energy (ME)ENRGY k/100g	349	346	353	348
DM	90.1	89.7	90.2	90.1

* The premix (Vitam. and Min.) was included at an amount of three kilograms per ton of diet and each kilogram of the premix delivered the following in mg or I.U. : vitamin A 12,000 IU, vitamin D3 2000 IU, vitamin E 40 mg, vitamin K3 4 mg, vitamin B1 3 mg, vitamin B2 6 mg, vitamin B6 4 mg, vitamin B12 0.03 mg, pantothenic acid 12 mg, folic acid 1.5 mg, chloride 700 mg, mn 80 mg, copper 10 mg, se. 0.2 mg, iron 0.4 mg, fe. 40 mg, zinc 70 mg, and co. 0.25 m.

Table 3. The proximate analysis of *Moringa Oliefera* leaves (%)

Item	Moisture	C.P	C.F	E.E	ASH	NEF
MOLM	8.5	28	17	10.6	12	23.9
Item	**DM**	**C.P**	**C.F**	**E.E**	**ASH**	**NEF**
MOLM	930	267.9	790	64	138.9	23.9

Table 4. Effect of dietary levels of *Moringa oleifera* leaves meal on growth performance (g) of broiler chicks during the starter period (7-21 days)

Item	*Moringa oleifera leaf meal,* (%)				
	Control	**2%MOLM**	**3%MOLM**	**5%MOLM**	**Sign.**
			Live body weight (g)		
Initial weight at 7 day	176	181	176	180	
Day 14	$321^{ab} \pm 5.36$	$326^{a} \pm 4.56$	$321^{ab} \pm 5.36$	$299^{b} \pm 7.37$	*
Day 21	$620^{a} \pm 16.7$	$627^{a} \pm 10.3$	$609^{a} \pm 25.8$	$653^{a} \pm 17.1$	NS
			Body weight gain (g)		
Day 7-14	$145^{a} \pm 5.93$	$146^{a} \pm 9.58$	$145^{a} \pm 6.61$	$119^{a} \pm 5.49$	NS
Day 14-21	$300^{a} \pm 12.1$	$301^{a} \pm 14.8$	$289^{a} \pm 28.9$	$354^{a} \pm 14.6$	NS
Day 7-21	$445^{a} \pm 17.3$	$447^{a} \pm 7.60$	$434^{a} \pm 26.6$	$472^{a} \pm 12.9$	NS
			Feed intake (g)		
Day 7-14	$156^{b} \pm 8.32$	$164^{ab} \pm 8.14$	$180^{a} \pm 0$	$157^{b} \pm 0.66$	*
Day 14-21	$334^{b} \pm 14.6$	$363^{b} \pm 5.50$	$396^{b} \pm 25.5$	$501^{a} \pm 23.3$	*
Day 7-21	$490^{c} \pm 6.34$	$527^{bc} \pm 8.73$	$576^{b} \pm 25.5$	$658^{a} \pm 22.7$	*
			Feed conversion ratio (g. feed/g. gain)		
Day 7-14	$1.08^{b} \pm 0.01$	$1.13^{ab} \pm 0.08$	$1.24^{ab} \pm 0.05$	$1.33^{a} \pm 0.06$	*
Day 14-21	$1.12^{a} \pm 0.09$	$1.21^{a} \pm 0.04$	$1.42^{a} \pm 0.23$	$1.42^{a} \pm 0.08$	NS
Day 7-21	$1.11^{a} \pm 0.05$	$1.18^{a} \pm 0$	$1.35^{a} \pm 0.14$	$1.41^{a} \pm 0.04$	NS

a, b, c, *etc*. indicates that the different litters at the same column are statistically different ($P \leq 0.05$). NS: Not significant ($p \geq 0.05$), *: Significant ($p < 0.05$)

In agreement with the present results, **Banjo (2012)** showed that increasing the diet of broiler chicks with 0, 1, 2 and 3% MOLM significantly raised feed consumption to 2% MOLM. **Dey and De (2013),** adding MOLM to broiler diets at levels of 0.25 or 0.40% significantly (P< 0.01) boosted feed intake compared to controls. The findings of the ratio of feed conversion revealed that there was no statistically significant variance (P≥0.05) between the control group and the 23% protein diet with MOLM addition. On the other hand, **Mikhail *et al.* (2020)** investigated the effects of MOLM at levels of 0, 2.5, 5, and 7.5% in broiler chicks and found that birds fed on a diet containing (5% MOLM) had the greatest total feed intake and the best feed conversion ratio.

Grower period (21-35 days)

Regarding the grower period of MOLM dietary feeding effect on live body weight at day 28 and body weight gain at the period (21–28 day), In comparison to the control group, the findings revealed no statistically significant (P≥0.05) difference among the various therapies. At 35 day the chicks fed on the diets with MOLM had a higher live body weight than those fed on the control diet, with the highest live body weight observed in the diet contained 5% MOLM.

Regarding body weight gain at days 28–35 and 21–35, the chicks fed on the diets with MOLM had higher body weight gain than those fed on the control diet (P<0.05), with the highest weight gain observed in the diet with 5% MOLM.

Table 5 supported the findings of **Adeyemi *et al.* (2018)**, who discovered that adding *Moringa* leaves meal to 5% of broiler diet increased the birds' growth performance and feed conversion ratio. Also, another investigation by **Abdel-Daim *et al.* (2019)** discovered that using Moringa leaf powder in broiler feed decreased the incidence of coccidiosis, a typical intestinal condition in chicken. The same outcomes have been attained by **Mikhail *et al;* (2020)** who investigated the effects of MOLM on broiler chicks at levels of 0, 2.5, 5, and 7.5% and found that birds fed on MOLM acquired substantially (P<0.05) more weight than chickens fed the control diet. The largest body weight was seen in birds fed a (5% MOLM) diet. Furthermore, MOLM has been found to have antioxidant properties, which can help protect poultry from oxidative stress and improve their overall health. A study conducted by **Kumari *et al.* (2021)** realized that adding *Moringa* leaf powder to broiler feed improved the birds' antioxidant status and reduced oxidative stress. The higher-end body and weight increase could also be attributable to the high digestibility of MOLM, which may enhance nutrient absorption **(Backer, 1995)** on the basis of **Paguia *et al.* (2014)**. **El-Kashef *et al.* (2017)**. These results might be the result of *Moringa's* high nutrient content (**Fahey *et al.* 2001)** and antibacterial capabilities **(Kakengi *et al.* 2007)**.

In relation to feed intake and feed conversion ratio, the findings indicated that the addition of MOLM to the 19% protein didn't significantly impact an increase or decrease in those values. **Samia *et al.* (2010)** revealed that feed intake increased significantly as CP dropped from 23% to 19%. MOLM has been said to enhance the health of chickens in addition to enhancing growth performance. Furthermore, **Banjo (2012)** showed that including 0, 1, 2, and 3% MOLM in the diet of broiler chickens significantly boosted feed consumption by up to 2% MOLM. Additionally, according to **Dey and De (2013),** adding MOLM to broiler diets at levels of 0.25 or 0.40% significantly (P0.01) boosted feed intake compared to controls. Additionally, **Nkukwana *et al.* (2014)** discovered that, with the exception of 3, 9, and 15 g/kg, birds supplemented with MOLM had the worst FCR (P<0.05) among treatments during the 0 to 21 and 0 to 35- day timeframes. Using 0.20, 0.30, 0.40, and 0.50% MOLM in broiler diets did not significantly (P0.05) affect the broilers' feed consumption and FCR. **Omede *et al.* (2020)** found similar findings, stating that broilers fed a diet containing MOLM showed improved weight gain, feed intake, and feed conversion ratio when compared to the control group.

Table 5. Effect of dietary levels of *moringa oleifera* leaves meal on growth performance (g) of broiler chicks during the grower period (21-35 days)

Item	*Moringa oleifera* leaf meal, (%)				
	Control	2%MOLM	3%MOLM	5%MOLM	Sign.
Live body weight (g)					
Initial weight at 21day	$620^{a} \pm 16.7$	$627^{a} \pm 10.3$	$609^{a} \pm 25.8$	$653^{a} \pm 17.1$	NS
Day 28	$1101^{a} \pm 12.5$	$1084^{a} \pm 33.2$	$1124^{a} \pm 63.9$	$1113^{a} \pm 103$	NS
Day 35	$2200^{b} \pm 57.7$	$2308^{b} \pm 98.0$	$2517^{ab} \pm 60.7$	$2675^{a} \pm 81.2$	*
Body weight gain (g)					
Day 21-28	$481^{a} \pm 5.20$	$457^{a} \pm 32.1$	$515^{a} \pm 89.7$	$460^{a} \pm 87.6$	NS
Day 28-35	$1099^{b} \pm 52.1$	$1223^{b} \pm 99.8$	$1393^{ab} \pm 11.2$	$1562^{a} \pm 86.6$	*
Day 21-35	$1580^{b} \pm 54.3$	$1681^{ab} \pm 87.8$	$1907^{ab} \pm 86.4$	$2023^{a} \pm 78.5$	*
Feed intake (g)					
Day 21-28	$821^{a} \pm 43.5$	$784^{a} \pm 30.9$	$791^{a} \pm 67.3$	$762^{a} \pm 81.3$	NS
Day 28-35	$1452^{a} \pm 95.5$	$1404^{a} \pm 34.7$	$1498^{a} \pm 29.6$	$1584^{a} \pm 48.1$	NS
Day 21-35	$2273^{a} \pm 90.2$	$2188^{a} \pm 15.3$	$2288^{a} \pm 95.6$	$2346^{a} \pm 124$	NS
Feed conversion ratio (g. feed/g. gain)					
Day 21-28	$1.71^{a} \pm 0.10$	$1.72^{a} \pm 0.06$	$1.58^{a} \pm 0.12$	$1.70^{a} \pm 0.12$	NS
Day 28-35	$1.32^{a} \pm 0.05$	$1.16^{ab} \pm 0.08$	$1.08^{ab} \pm 0.02$	$1.02^{b} \pm 0.08$	*
Day 21-35	$1.43^{a} \pm 0.04$	$1.30^{a} \pm 0.04$	$1.19^{a} \pm 0.01$	$1.15^{a} \pm 0.04$	NS

a, b, c, *etc*. indicates that the different litters at the same column are statistically different ($P \leq 0.05$). NS: Not significant ($p \geq 0.05$), *: Significant ($p < 0.05$)

Carcass Characteristics

Based on Table 6, it appeared that the different diets didn't have a significant effect on each of carcass weight, heart, gizzard, gut, liver, or giblets ($P \geq 0.05$). Although the addition of MOLM indicated a decrease in liver weight, head, and lungs, it also indicated an increase in the dressing, but this difference was not considered statistically significant ($P \geq 0.05$). The same outcomes have been attained by **Karthivashan *et al.* (2015),** who claimed broiler feed supplemented with 0, 0.5, 1.0, and 1.5% of MOLM extracts had a significantly greater dressing percentage ($P < 0.05$) than broiler feed provided control. In addition to improving carcass characteristics, *Moringa* leaves have also been demonstrated to possess antibacterial and antioxidant qualities that help enhance poultry health (**Leung *et al.* 2018**).

Digestion Coefficients and Nitrogen Balance

The effect of dietary *Moringa oleifera* leaf meal on digestion coefficient (%) of growing broiler the apparent digestibility of crude protein (CP), crude fiber (CF), ether extract (EE), dry matter (DM), nitrogen-free extract (NFE), and nitrogen balance percentage (N.B%) was shown in Table 7. Firstly, the addition of MOLM had variable effects on the digestion coefficient of nutrients of the diets. Some digestion coefficient nutrients, such as CP, CF, DM, and NEF, showed no significant differences among the diets, while others, such as ether extract and N.B % showed significant differences based on the level of MOLM in the diet. Second, the addition of MOLM to diet had significant effects on the nitrogen balance (N.B %) of the chicks. the chicks fed on the diets with 2% and 5% MOLM had a significantly higher N.B% than those on the control diet.

Table 6. Effect of dietary levels of *moringa oleifera* leaf meal on carcass characteristics of growing broiler

Item	*Moringa oleifera leaf meal, (%)*			
	Control	**2%MOLM**	**3%MOLM**	**5%MOLM**
Carcass weight g	$2000^{a} \pm 57.7$	$2000^{a} \pm 57.7$	$2000^{a} \pm 57.7$	$2000^{a} \pm 57.7$
Head (g)	$52.0^{a} \pm 0.58$	$50.0^{a} \pm 2.52$	$51.67^{a} \pm 0.88$	$51.67^{a} \pm 0.88$
Heart (g)	$10.0^{a} \pm 0.58$	$10.0^{a} \pm 0.58$	$9.67^{a} \pm 0.33$	$9.33^{a} \pm 0.67$
Gizzard (g)	$53.33^{a} \pm 1.67$	$53.33^{a} \pm 1.67$	$53.33^{a} \pm 1.67$	$53.33^{a} \pm 1.67$
Gut (g)	$143^{a} \pm 0.58$	$143^{a} \pm 0.58$	$143^{a} \pm 0.58$	$143^{a} \pm 0.58$
Liver (g)	$44.67^{a} \pm 2.91$	$44.33^{a} \pm 2.96$	$45.33^{a} \pm 2.85$	$44.67^{a} \pm 2.91$
Lungs (g)	$9.33^{a} \pm 0.33$	$9.0^{a} \pm 0.58$	$8.67^{a} \pm 0.88$	$9.0^{a} \pm 0.58$
Giblets* (g)	$108^{a} \pm 3.51$	$108^{a} \pm 3.84$	$108^{a} \pm 4.10$	$107^{a} \pm 3.93$
Dressing (%)	$90.6^{a} \pm 0.26$	$96.7^{a} \pm 0.56$	$92.0^{a} \pm 0.40$	$93.8^{a} \pm 0.55$

a, b, c, *etc*. indicates that the different litters at the same column are statistically different ($P \leq 0.05$).*giblets = gizzard+ liver +heart.

Table 7. Effect of dietary levels of *moringa oleifera* leaf meal on digestion coefficient (%) of growing broiler

Items	***Moringa oleifera* leaf meal, (%)**			
	Control	**2%MOLM**	**3%MOLM**	**5%MOLM**
C.P	$84.73^{a} \pm 0.37$	$83.73^{a} \pm 0.37$	$84.37^{a} \pm 0.49$	$84.40^{a} \pm 0.40$
C.F	$25.70^{a} \pm 6.64$	$17.89^{a} \pm 4.85$	$24.84^{a} \pm 3.73$	$21.01^{a} \pm 4.92$
E.E	$71.36^{ab} \pm 0.60$	$72.80^{a} \pm 2.71$	$62.81^{b} \pm 2.22$	$67.41^{ab} \pm 4.51$
D.M	$90.10^{a} \pm 0.10$	$89.77^{a} \pm 0.39$	$90.20^{a} \pm 0.10$	$90.10^{a} \pm 0.10$
NEF	$74.38^{a} \pm 0.11$	$74.54^{a} \pm 0.22$	$72.83^{a} \pm 0.77$	$74.54^{a} \pm 0.58$
N.B%	$30.31^{b} \pm 0.30$	$35.76^{a} \pm 1.58$	$31.02^{b} \pm 0.76$	$34.63^{a} \pm 0.83$

a, b, c, *etc*. indicates that the different litters at the same column are statistically different ($P \leq 0.05$).

Blood Constituents

Table 8 demonstrate the impact of dietary amounts of *Moringa oleifera* leaves meal on the blood biochemical parameters of broiler chickens. According to the Table 8, the addition of MOLM to broiler diets meal had varying impacts on the chickens' blood chemistry measures. Some parameters, such as total protein, albumin, globulin, A/G ratio, total lipids, HDL, total cholesterol, and AST, showed no significant differences among the diets. These results are supported by those obtained by serum total protein; albumin, total cholesterol, and the difference in total lipids between the groups given a diet with or without Moringa was not significant. According to **Yakubu *et al.* (2013)** Others, like glucose, LDL, and ALT, showed substantial variations based on the amount of MOLM in the diet. Similarly, **Makanjuola *et al.* (2014)** discovered that using 0.2, 0.4, and 0.6% MOLM had no impact on serum total protein, albumin, globulin, and blood cholesterol levels, all of which were lower in all treatments in comparison to the control group.

Second, the chicks fed on diets that had MOLM, in addition, LDL levels that were considerably lower than those on the control diet, suggesting a possible improvement in cardiovascular health. **Dey and De (2013)** also discovered that adding 0.25 or 0.40% MOLM to broiler diets resulted in a substantial ($P<0.01$) decrease in total cholesterol, triglyceride, LDL cholesterol, and an increase in HDL cholesterol in the birds. **Makanjuola *et al.* (2014)** discovered the same results for MOLM and discovered that the usage of 0.2, 0.4, and 0.6% MOLM had no effect on serum total protein, albumin, globulin, blood cholesterol, and LDL-cholesterol had lower levels in all treatments compared to control**.**

Third, the chicks fed on the diet contained 3% MOLM had a significantly increased glucose than those on the other diets ($P< 0.05$); however, the chicks fed on the diet with 5% MOLM had a significantly higher ALT than the control group ($P<0.05$). These studies' findings concur with those of **El Kashef *et al.* (2017)**, who discovered that birds fed a food enriched with 0.40% MOLM had considerably higher blood glucose levels than birds in the control group. But on the other hand, rats' blood glucose levels fell after receiving *Moringa oleifera* aqueous leaf extract, according to **Jaiswal *et al.* (2009)**. With all MOLM levels, blood AST and ALT values dropped. Since ALT and AST are believed to be present in the liver, when the liver is injured, in the blood, it releases these enzymes **(Kaplan *et al.*, 2003).**

From the above, it is evident that the previous effects and modes of action may be related to the moringa leaves' high concentrations of polyphenols and antioxidant vitamins including vitamin C, vitamin E, and beta-carotene **(Kidmose *et al.* (2006)**. Compared to conventional antioxidants like ascorbic acid, these ingredients improve their antioxidant activity significantly **(Yang *et al.* (2006)**. Additionally, *Moringa oleifera* leaves contain simple sugar, vitamin A, iron, vitamin B1 and B2, and anti-inflammatory chemicals (**Ferreira *et al*., 2008; Konmy *et al.*, 2016)**. These substances support the body's ability to operate and preserve the structural stability and overall health of its tissues.

Economic Efficiency

The findings revealed that the highest price of starter, LBW, total revenue, and net revenue were in diet contained 5% MOLM, followed by 3% MOLM, and the lowest values were in the control group without MOLM. Regarding economic efficiency and relative economic efficiency, the results found that the highest values were in diet contained 3% MOLM. Therefore, using dietary MOLM increased the net revenue and decreased the feed cost for broilers and the price for growers. However, the results showed no effect for MOLM on fixed cost or price LBW similarly, another study conducted by **Nworgu *et al.* (2018)** found that the inclusion of Moringa in broiler feed led to a significant reduction in feed cost and an improvement in feed efficiency (Table 9).

Table 8. Effect of dietary levels of *Moringa oleifera* leaf meal on the blood biochemical parameters of broiler chicks

Item	*Moringa oleifera* leaf meal, (%)			
	Control	2%MOLM	3%MOLM	5%MOLM
Total protein g/dl	$3.32^{a} \pm 0.24$	$2.96^{a} \pm 0.21$	$2.93^{a} \pm 0.03$	$3.19^{a} \pm 0.31$
Albumin (g/dl)	$1.74^{a} \pm 0.01$	$1.65^{a} \pm 0.04$	$1.69^{a} \pm 0.12$	$1.55^{a} \pm 0.08$
Globulin (g/dl)	$1.59^{a} \pm 0.24$	$1.31^{a} \pm 0.25$	$1.24^{a} \pm 0.09$	$1.64^{a} \pm 0.23$
A/G ratio	$0.91^{a} \pm 0.14$	$0.80^{a} \pm 0.18$	$0.75^{a} \pm 0.10$	$1.05^{a} \pm 0.10$
Total Lipids (mg/dl)	$358^{a} \pm 6.75$	$385^{a} \pm 0.0$	$363^{a} \pm 11.3$	$366^{a} \pm 9.30$
Glucose (mg/dl)	$207^{b} \pm 3.0$	$210^{b} \pm 2.33$	$218^{a} \pm 2.33$	$202^{b} \pm 2.33$
LDL (mg/dl)	$103^{a} \pm 0.0$	$87.3^{b} \pm 0.0$	$83.2^{b} \pm 0.0$	$86.5^{b} \pm 6.84$
HDL (mg/dl)	$86.8^{a} \pm 2.74$	$85.3^{a} \pm 1.67$	$91.2^{a} \pm 2.30$	$87.9^{a} \pm 3.81$
Total cholesterol (mg/dl)	$190^{a} \pm 2.74$	$173^{a} \pm 1.67$	$174^{a} \pm 2.30$	$174^{a} \pm 10.4$
ALT (U/l)	$16.3^{b} \pm 0.33$	$17.3^{ab} \pm 0.88$	$15.3^{b} \pm 0.67$	$18.7^{a} \pm 0.33$
AST (U/l)	$132^{a} \pm 1.79$	$138^{a} \pm 13.3$	$134^{a} \pm 2.09$	$136^{a} \pm 13.6$

a, b, c, *etc*. indicates that the different litters at the same column are statistically different ($P \leq 0.05$).

Table 9. Effect of dietary levels of *Moringa olifera* leaf meal (MOLM) levels on the economic efficiency of growing broiler

Items	*Moringa oleifera* leaf meal, %			
	Control	2%MOLM	3%MOLM	5%MOLM
Fixed cost (L.E.)	15	15	15	15
Price of kg starter	7.2	8.1	8.9	10
Price of kg grower	13.8	7.9	8.9	10.1
Total feed cost	21	16	18	20
Total cost	35.94	31.09	32.57	35.49
LBW kg.	2.2	2.31	2.52	2.68
Price LBW	28	28	28	28
Total revenue (L.E.)	61.6	64.6	70.45	74.9
Net revenue (L. E.)	25.7	33.5	37.9	39.4
Economic efficiency	71.4	107.8	116.3	111.7
Relative economic efficiency (%)	100	107	108	96

Fixed cost: Bird price and rearing cost, Total revenue: Assuming that the selling price of one kg live body weight is 28 LE, Net revenue: Total revenue – total cost, Economic efficiency (EEF): Net revenue per unit total cost, Relative economic efficiency (R.E.F): Relative economic efficiency of the control =100

Conclusion

In conclusion, using Moringa leaves in poultry feed has several economic benefits, including reduced feed cost, improved productivity, and reduced environmental impact. Additionally, Moringa can also improve the health of poultry.

REFERENCES

Abdel-Daim, M.A.; El-Hack, M.E.A. and Alagawany, M. (2019). The use of *Moringa oleifera* leaves as a feed additive for broiler chickens. Anim. Nutr., 5 (4): 382-386. doi:10.1016/j.aninu. 2019. 05. 003.

Adeyemi, O. A.; Ojebiyi, O. O. and Akinjogunla, O. J. (2018). The effects of *Moringa oleifera* leaf meal on the performance of broilers. Animal Nutrition and Feed Technology, 18(4), 433-441.

AOAC (2010). Official Methods of Aalysis. 6th Ed., Association of Official Anal. Chem., Washington, DC; USA.

Atuahene, C.C.; Attoh-Kotoku, V.; Fosu, K.D.; Amissah, S.E.; Sarfo, F.K. and Mensah, J.J. (2010). Preliminary study of the effect of feeding *Moringa oleifera* leaf meal as a feed ingredient on the growth performance of broiler chickens. Proc. 28th and 29th Ghana Anim. Sci. Ass. Held at the Univ. Ed., Winneba, Mmpong Campus, 9th Aug., 2008, 72-75.

Backer, K. (1995). Studies on utilization of *Moringa oleifera* leaves as animal feed. Institute for Animal Production in the Tropics and Subtropics, 480. Univ. Hohenheim Stuttgart, 15.

Banjo, S. (2012). Growth and performance as affected by inclusion of *Moringa oleifera* leaf meal in broiler chick diet. J. Biol. Agric. Healthcare, 2 (9): 35-38.

Dey, A. and De, P.S. (2013). Infiuence of *Moringa oleifera* leaves as a functional feed additive on the growth performance, carcass characteristics and serum lipid profile of broiler chicken. Indian J. Anim. Res., 47 (5): 449.

Duncan, D.B. (1955). Multiple Range and Multiple F-teste. Biometrics, 11 : 1-42.

El-Kashef, M.M.; Abdel-Ghaffar, M.A.; Khalil, H.A. and Ali, A.M. (2017). Effect of feeding (*Moringa oleifera*) leaf meal on quail performance under north Sinai conditions. Sinai J. Appl. Sci., 6: 2.

Fahey, J.W.; Zakmann, A.T. and Talalay, P. (2001). The chemical diversity and distribution of glucosinolates and isothiocyanaes among plants. Corrigendum Phytochem., 59: 200-237.

Ferreira, P.M.P.; Farias, D.F.; Oliveira, J.T.D.A and Carvalho, A.D.F.U. (2008). *Moringa oleifera*: Bioactive compounds and nutritional potential. Rev. Nutr., 21: 431-437.

Jaiswal, D.; Rai, K.P.; Mehta, K.A. and Watal, G. (2009). Effect of *Moringa oleifera* Lam. leaves aqueous extract therapy on hyperglycemic rats. J. Ethnopharmacol., 123(3): 392-396.

Jiya, M.M.; Ismail, M.N. and Musa, N.N. (2020). The use of *Moringa oleifera* leaf meal in poultry feeding: a review. Tropical Anim. Sci. J., 43(3): 241-254.

Jakobsen, P.E.; Kirston, S.G. and Nelson, H. (1960). Digestibility trials with poultry. 322 bertning fraforsgs laboratoriet, udgivet of stants. Husdyrbugsud valy-Kabenhaven.

Kakengi, A.M.V.; Kaijage J.T.; Sarwatt S.V.; Mutayoba S.K.; Shem M.N. and Fujihara, T. (2007). Effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. Livestock Res. Rural Dev., 19: 120.

Kaplan, L.A.; Pesce, A.J. and Kazmierczak, S.C. (2003). Liver Function. In: Sherwin, J.E. (Ed.), Clinical Chemistry, 4th Ed. Elsevier Sci., St. Louis, Toronto.

Karthivashan, G.; Arulselvan, P.; Alimon, A.; Ismail, I.S. and Sharida Fakurazi, S. (2015). Competing Role of Bioactive Constituents in Moringaoleifera Extract and Conventional Nutrition Feed on the Performance of Cobb 500 Broilers. Bio. Med., Res. Int., Article ID 970398, 13.

Khan, S.; Rehman, M.S.; Rashid, M.H.; and Haq, A.U. (2017). *Moringa oleifera*: a natural gift-A review. J. Pharm. and Nutr. Sci., 7 (1): 13-19.

Kidmose, U.; Yang, R.Y.; Thilsted, S.H.; Christensen, L.P. and Brandt, K. (2006). Content of carotenoids in commonly consumed Asian vegetables and stability and extractability during frying. J. Food Comp. Anal., 19:562-571.

Konmy, B.B.S.; Olounlade, P.A.; Allou, S.D.; Azando, E.V.B. and Hounzangbe-Adote, M.S. (2016). A review on phytochemistry and pharmacology of *Moringa oleifera* leaves (*Moringaceae*). J. Pharm. and Phytochem., 5 (5): 325-330.

Kumari, S.; Mandal, A.B. and Reddy, A.G. (2021). *Moringa oleifera* leaf meal as feed supplement improves growth performance and antioxidant status of broilers. Int. J. Livestock Res., 11(2): 27-36. doi: 10.5455/ijlr.2020070701325.

Leung, H.K.; Chen, W.; Yue, G.G.L. and Kwok, P.C.L. (2018). Review on the pharmacological activities and molecular mechanisms of *Moringa oleifera*. Int. J. Molec. Sci., 19(7)

Mabruk, A.A.; Talib, H.N.; Mohamed, M.A. and Alawad, A.H. (2010) . A note on the potential use of *Moringa oleifera* tree as animal feed, Hillat Kuku. J. Vet. Med. and Anim. Prod., 1 (2): 184- 188.

Makanjuola, B.A.; Obi, O.O.; Olorungbohunmi, T.O.; Morakinyo, O.A.; Oladele-Bukola, M.O. and Boladuro, B.A. (2014). Effect of *Moringa oleifera* leaf meal as a substitute for antibiotics on the performance and blood parameters of broiler chickens. Livestock Res. Rural Develop., 26 (8).

Mikhail, W. Z.; Abd El-Samee, M. O.; El-Afifi, T. M., & Mohammed, A. R. (2020). Effect of feeding *Moringa oleifera* leaf meal with or without enzyme on the performance and carcass characteristics of broiler chicks. Plant Archives, 20(1), 3381-3388.

Nkukwana, T.T.; Muchenje, V.; Pieterse, E.; Masika, P.J.; Mabusela, T.P.; Hoffman, L.C. and Dzama, K. (2014). Effect of *Moringa oleifera* leaf meal on growth performance, apparent digestibility, digestive organ size and carcass yield in broiler chickens. Livestock Sci., 161: 139-146.

NRC (1994). National Research Council Nutrient requirements of poultry. 9th Ed. Nat. Acad. Press, Washington.DC; USA.

Nworgu, F.C.; Olomu, J.M.; Okoli, I.C.; and Opara, C.C. (2018). Effect of dietary *Moringa oleifera* leaf meal on the performance and blood parameters of broiler chickens. J. Agric. Sci., 10 (7): 10-17.

Omede, A.A.; Nwagu, B.I. and Omede, F.O. (2020). Growth performance and nutrient digestibility of broiler chickens fed diets containing graded levels of *Moringa oleifera* leaf meal. Anim. Nutr., 6 (4): 381-386

Paguia, H.M.; Paguia, R.Q.; Flores, R.C. and Balba, C.M. (2014). Utilization and evaluation of *Moringa oleifera* as poultry feeds. Monograph No. 11. Res. and Develop. Office, Bataan Peninsula State Univ. City Balanga, Philippines.

Samia, K.M.Z.U.; Jabbar, M.A.; Mehmud, A.; Abbas, M.M. and Mahmood, A. (2010). Effect of lysine supplemention in low protein diets on performance of growing broilers, Pak.Vet. J., 30:17-20.

SAS (2004). Institute Inc., SAS procedures Guide for personal Computers, Stat. Anal. System Inst., Inc., Cary, N.C.

Yakubu, B.; Nathan, J.M. and Yahya, M.S. (2013). Effects of substituting groundnut cake with moringa (*Moringa oleifera*) leaf meal on growth performance, carcass yield and haematological profile of weaner rabbits. J.

Yang, R.Y.; Tsou, S.C.; Lee, T.C.; Chang, L. and Kuo, G.P.L. (2006). Moringa, a novel plant rich in antioxidants, bioavailable iron, and nutrients. Ame. Chem. Soci. Symposium Series, 925: 224–239.

Yousha, B.A.; Abdel Ghaffar, M.A.; Ali, A.M. and Sabri, H.M.(2020a). Effect of short-term divergent selection for body weight at4 week of age in *Japanese quail* under North Sinai conditions. A- Effect on body weight at 4 wk of age. Sinai J. Appl. Sci., 9 (2) :191-206.

Yousha, B.A.; Abdel Ghaffar, M.A.; Ali, A.M. and Sabri, H.M. (2020b). Effect of short-term divergent selection for body weight at 4 weeks of age in *Japanese quail* under North Sinai conditions. B- Effect on growth traits at 4 weeks of age. Sinai J. Appl. Sci.,9 (2): 207-224.

الملخص العربي

أثر استخدام أوراق المورينجا أوليفيرا المجففة على النمو وخصائص الذبيحة، ومؤشرات الدم في دجاج التسمين

اية جمال عابد، محمود أحمد عبد الغفار، كامل سيد أحمد، أحمد محمد علي

قسم الانتاج الحيواني والداجني – كلية العلوم الزراعية البيئية بالعريش – جامعة العريش – مصر

تهدف الدراسة إلى معرفة أثر واستخدام أوراق المورينجا في تغذية كتاكيت التسمين عن طريق احلالها بدلاً من الصويا، وقد أجريت في مزرعة قسم الإنتاج الحيواني والداجنى في كلية العلوم الزراعية البيئية بجامعة العريش بشمال سيناء، مصر. أجريت التجربة باستخدام 120 كتكوت تسمين (روس) غير مجنس عمر7ايام وتم التوزيع عشوائيا على المعاملات الغذائية وتمت التغذية على علائق تحتوي على اربعة مستويات من اوراق المورينجا صفر و2و3و5% تم احلالها بدلاً من فول الصويا وتم تقسيمها إلى 4 مجموعات كل مجموعة 30 كتكوتًا و كل مجموعة تتكون من 3 مكررات كل مكررة 10 كتاكيت خلال فترة التجربة 7-35 يوم. وتم تقدير كل من وزن الجسم الحي ومقدار الزيادة المطلقة في وزن الجسم ومعدل استهلاك الغذاء ومعدل التحويل الغذائي ومعدل الاستفادة من البروتين.وفى نهاية التجربة اختيرت عشوائيا تسعة طيور من كل مجموعة وذبحت من اجل قياس صفات وقياس بعض التغييرات البيوكيمائية للدم وفي نهاية التجربة تم عمل دراسة اقتصادية لتقييم العلائق المختلفة. أظهرت النتائج زيادة في وزن الجسم الحي وزيادة وزن الجسم الحي مع تقدم العمر، ولكن لم يكن لأوراق المورينجا أوليفيرا أي تأثير على وزن الجسم الحي أو زيادة وزن الجسم الحي. اما لاستهلاك العلف، فإن إضافة اوراق المورنجيا إلى العلائق كان له تأثير أعلى على تناول العلف مقارنة بالمجموعة الكنترول. كذلك وضحت النتائج تفوق واضح للطيور المغذاة على العلائق خلال فترة البادئ والنمو على التوالي المضاف اليها أوراق المورينجا في وزن الجسم والزيادة في وزن الجسم ومعدل استهلاك الغذاء ومعامل النمو وكذلك معدلات أفضل في معامل تحويل لكن لم يكون هناك تأثيرًا معنويا على معاملات هضم المواد الغذائية لدجاج التسمين باستثناء الزيادة في نسبة التوازن النيتروجيني مع إضافة اوراق المورينجا. لم يكن هناك تأثير على خصائص الذبيحة مقارنة بالمجموعة الكنترول كما أظهرت النتائج على المتغيرات البيوكيميائية عدم وجود فروق ذات دلالة إحصائية بين المعاملات المختلفة. باستثناء الجلوكوز، LDL ، و ALT. أخيرًا توضح النتائج ان اضافة 3-5 ٪ من أوراق المورينجا أوليفيرا في علائق الدجاج، يمكن أن يؤدي إلى زيادة الكفاءة الاقتصادية وصافي الإيرادات مقارنة بالكنترول.

الكلمات الإسترشادية: الكتاكيت، أوراق المورينجا أوليفيرا، الأداء الإنتاجي.

REVIEWERS:
Dr. Mamdouh O. AbdelSamie | mamdouh20466@yahoo.com
Dept. Ani. and Poult. Prod., Fac. Agric., Cairo Univ., Egypt.
Dr. Adel Ibrahem Attia | dradel_attia@yahoo.com
Dept. Ani. and Poult. Prod., Fac. Agric., Zagazig Univ., Egypt.