PERFORMANCE AND HISTOMORPHOLOGICAL PARAMETERS OF BROILER CHICKS FED LOW CRUDE PROTEIN DIET SUPPLEMENTED WITH MORINGA OLEIFERA LEAVES POWDER

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ABSTRACT: The present experiment was conducted in order to investigate the effect of Moringa Oleifera Leaves powder on the performance, some blood serum components, some histomorphological measurements and economic efficiency of broiler chickens. A total of 225 Cobb unsexed one - day old broiler chicks, were distributed at random into 5 treatments each in 3 replicates, 15 chicks each. Moringa Oleifera leaves powder (MOL) was added at the levels of 0, 0.25, 0.50 and 0.75% to low crud protein diet (LCP, 20 and 17%, negative control) compared to the normal crud protein (23 and 20%, positive control), respectively at the starter (1- 21 d) and at the finisher (22- 35d) period.

Results indicated that, chicks fed the low crude protein diet supplemented with Moringa Oliefera leaves powder (MOL) had significantly ($P \leq 0.05$) higher body weight, body weight gain, daily feed intake and performance index. Feed conversion ratio, European efficiency index and relative economic efficiency were also improved with the supplementation. Chicks fed low crude protein diet supplemented with 0.25 or 0.50% MOL have the highest dressing weight (1753 and 1738g) with no significant differences between them compared and increased serum total protein and glucose levels, while significantly decreased serum total cholesterol and aspartic transaminase (AST) enzyme compared to the other treatments with increasing the levels of MOL up to 0.50%. Morphological sections of small intestine revealed that villi height, width and height: width ratios were increased by the supplementation of different levels of MOLM (0.25 and 0.50%) but not significant except in duodenum villi width and in the ration between height and width.

In general, the obtained results indicated that supplementation of 0.25% Moringa Oliefera Leaves, MOL can be used in broiler diets with low protein level to get the heaviest weight, best feed conversion, performance index, due to an increase in small intestinal absorption and activity. This, in turn, resulted in an increase in European efficiency index and economic efficiency under the experimental conditions.

Key words: Moringa Oliefera Leaves powder, low crude protein, broilers, growth, carcass, serum components, histomorphological parameters and diet.

INTRODUCTION

Broiler production supplies the populations with animal proteins, but it is highly constrained by the availability, quality and cost of feed ingredients regardless of the system of production (Ugwuowo *et al.* 2019). Poultry plays very important role for mankind through food supply, income and employment generation, providing raw materials to some industries. Food and Agriculture Organization FAO (2010) reported that broiler chicken farm business has grown into a complete industry with rapid development due to the increasing and rapid demand for chicken meat especially when meat products from other farm animals have high retail prices.

In developing countries, the poultry production sectors are facing some problems, such as increased food costs; due to this, alternative sources have been sought in their diet that is available and not expensive. Poultry farming has a high impact in the economic and social spheres; since more than 60% of the animal protein consumed in the world comes from the poultry industry (Sagarpa, 2017). In Egypt poultry production sectors are facing some problems, one of which is the cost of feed due to high prices of protein and energy sources (Abbas, 2013). Feed cost accounts for 60 to 70% of the total cost of poultry production. The high cost of conventional feed ingredients in poultry diets has necessitated the investigation into un-conventional readily available feed stuffs. The impact of indigenous chickens in improving the nutritional status, income, food security and livelihood of small holders is significant owing to their low cost of production (FAO, 1997).

However, the recent hike in the prices of conventional feed ingredients is a major factor affecting net return on investment from the poultry business. This has compelled animal nutritionists to explore the incorporation of non-conventional feed stuffs in poultry diets. Any attempt to improve commercial poultry production and increase its efficiency therefore needs to focus on searching for alternative and better utilization of feed resources (Udedibie and Asoluka , 2008). However, the recent hike in the prices of conventional feed ingredients is a major factor affecting net return on investment from the poultry business. This has compelled animal nutritionists to explore the incorporation of non-conventional feed stuffs in poultry diets. Any attempt to improve commercial poultry production and increase its efficiency therefore needs to focus on searching for alternative and better utilization of feed resources (Udedibie and Asoluka, 2008).

In addition, researchers are searching for cheap, available, and safe alternative sources of protein and energy (Abbas, 2013). Scientists are also looking for natural antimicrobial ingredients, some legumes and tropical into poultry meals as an ingredient or addition to broiler chickens as a source to reduce feed costs and improve performance in broiler birds.

Moringa Oleifera is a tree with many uses and of great economic importance. It was incorporated into the poultry diet by nutritionists to examine its effects on broilers birds' productive performance. Moringa Oleifera leaves have the potential to supply some needed nutrients for the growth of broilers and reduce the cost of supplementary synthetic nutrients (Esiegwu, 2019). Nihad *et al.* (2016) reported the proximate composition of Moringa Oleifera to contain 5.89% ash, 17.41% fiber, 25.37% protein, 2.44% lipid and 39.02% total sugars and similarly Sodamade *et al.,* (2013) reported that the proximate and mineral composition of Moringa Oleifera leaves contained 6.00% ash, 2.43% crude fat, 5.43% crude fiber, 39.13% crude protein, 38.21% carbohydrate, 23.20mg/100g K, 214.00 mg/100g Na, 723 mg/100g Ca, 677.00 mg/100g Mg, 5.00 mg/100 g P, 187 mg/100g Fe, 252 mg/100g Mn, 55 mg/100g Cu and 548 mg/100g of Zn. The values reported is an indication that Moringa Oleifera leaves are nutritionally rich and could serve as supplements in broiler diets.

Therefore, the aim of this study was to assess the benefits of Moringa Oliefera leaves as a feed additive in broiler chickens in terms of growth performance, feed consumption, carcass characteristics, some serum blood parameters and some intestinal morphology of Cobb chicks.

MATERIALS AND METHODS

The present study was conducted at a private farm in Sadat City, Menoufia governorate, Egypt, throughout the experimental period from October to November 2018 in order to investigate the effect of some herbal feed additives on the performance, some blood serum biochemical parameters and some histomorphological measurements of broiler chickens.

a. Birds, housing and feeding:

Two hundred and twenty five, one day old broiler chicks (Cobb) were randomly assigned to five treatments, reared under similar management and hygienic conditions. Feed and water were provided *ad-libitum* during the experimental period (35 days). Artificial light was used to provide 24 hour photo period. Chicks were individually weighed, wing – banded and randomly assigned to five treatment (T_1, T_2, T_3, T_4 and T_5) groups nearly similar in average body weight, (3 replicates pens of 15 chick each, ~ 40g). Moringa Oliefera leaves powder was added at the levels of 0, 0.25, 0.50 and 0.75% to the low crud protein (LCP) diet (20 and 17%, negative control) compared to the normal crud protein (23 and 20%, positive control), respectively at the starter (1- 21 d) and at the finisher (22- 35d) period. Birds received their diets to save the nutrient requirements according to the NRC (1994, Tables 1 and 2).

b. Growth performance parameters:

Body weight (BW), body weight gain (BWG), feed intake (FI) and mortality were recorded weekly. Feed conversion ratio (FCR, g feed /g gain) was calculated every week during the experimental period. Performance index (PI) was calculated according to North (1981). Where: PI = live body weight, kg × 100/ feed conversion.

$$PI = \frac{\text{live body weight, kg}}{\text{feed conversion}} * 100$$

European efficiency index (EEI) was calculated also cited by Soltan and Kusainova (2012).

Where: EEI = (Mean BW, kg × Livability, %)/ (Marketing age, days × FCR) × 100.

$$EEI = \frac{\text{Mean BW, kg} \times \text{Livability, \%}}{\text{Marketing age, days} \times \text{FCR2}a} * 100$$

c. Carcass traits and histomorphological samples:

At the end of the experiment (5 weeks of age), 3 birds from each treatment around the average live body weight were randomly chosen, fasted for about 12 hours, weighed and slaughtered to complete bleeding, followed by plucking the feathers. Carcass without giblets and some giblets (liver, heart and gizzard) weights were calculated relative to live body weight as following:

Dressing % = Carcass weight (g) × 100 / Live body weight (g).

$$\text{Dressed carcass \%} = \frac{\text{Eveserated carcass weight}}{\text{Live body weight}} * 100$$

The small intestines of chicks were removed immediately, after slaughtering and segments of approximately 2 cm was taken from duodenum, jejunum and ileum at 35 day age for histological analysis. Segments referred to the midpoint of the duodenum (from gizzard to pancreo-biliary duct, duodenum), jejunum (the midpoint between the entry of the common bile duct and the Meckel's diverticulum), and ileum (from Meckel's diverticulum to ileocecal junction). Particular segments was gently flushed and rinsed with 0.9% physiological saline and then fixed in a 4% neutral-buffered formalin solution for histological study.

Intestinal samples were transferred from formaldehyde after dehydration by passing tissue through a series of

alcohol solutions, were cleared by xylene and were embedded in paraffin. All samples were sectioned at 5-µm thickness using a rotary microtome. Sections were sequentially transferred to glass slides and stained with Hematoxylin and Eosin (H and E). After being dried, sections were analyzed under a light microscope. Morphometric measurements were performed on 9 villi chosen from each sample. The height of intestinal villi was measured from the tip to the base of villi at the opening crypt, and the villus width was measured at its midpoint (Geyra et al., 2001).

Table 1. Composition and calculated analysis of the positive and negative control diets fed during starting period (1- 21d).

Ingredients	Positive control diets, T_1	Negative control diets, T_2	Moringa Oliefera Leaves levels, %		
			0.25, T_3	0.50, T_4	0.75, T_5
Yellow corn, 8.5%.	48.5	57.13	59.4	59.2	59.2
Soybean meal, 44%.	39.60	33.75	30.73	30.73	30.73
Corn gluten, 60%.	2.25	0.5	2.1	2.05	2
Vegetable oil.	5.70	4.82	4.00	4.00	4.00
MOL[1].	---	0.00	0.25	0.50	0.75
Di-calcium phosphate.	1.50	1.75	1.55	1.55	1.55
Limestone.	1.65	1.45	1.65	1.65	1.65
Vitamins and minerals mixture[2].	0.30	0.30	0.30	0.30	0.30
Salt.	0.30	0.30	0.30	0.30	0.30
Methionine[3].	0.20	---	0.20	0.20	0.20
Total	100	100	100	100	100
Calculated analysis (air dry basis)[4]:					
Crude protein,%.	23	20	20	20.01	20.05
ME, kcal/kg diet.	3096	3108	3101	3102	3100
C/P ratio.	134	155	155	155	154
Ca.	1.05	1.01	1.04	1.04	1.06
Av. P.	0.46	0.46	0.46	0.46	0.46

[1]Proximate composition of Moringa Oliefera leaves was cited by Esiegwu, 2019.

[2]Vitamins and minerals mixture at 0.30 % of the diet supplies the following/ kg of the diet: Vit. A, 12000 IU; Vit. D_3 , 2500 IU; Vit. E, 10 mg; Vit. K_3, 3 mg; Vit B_1, 1 mg; Vit. B_2, 4 mg; Pantothenic acid, 10 mg ;Nicotinic acid, 20 mg; Folic acid, 1 mg; Biotin, 0.05 mg; Niacin, 40 mg; Vit.B_6, 3 mg; Vit B_{12}, 0.02 mg; Choline chloride, 400 mg; Mn, 62 mg; Fe, 44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01 mg.

[2]DL – Methionine: 98% feed grade (98 % Methionine).

[4]Calculated according to NRC (1994).

Table 2. Composition and calculated analysis of the positive and negative control diets fed during finishing period (22- 35d).

Ingredients	Positive control diets, T_1	Negative control diets, T_2	Moringa Oliefera Leaves levels, %		
			0.25, T_3	0.50, T_4	0.75, T_5
Yellow corn, 8.5%.	56.96	67.8	66.22	66.03	65.93
Soybean meal, 44%.	34.50	25.55	25.5	25.45	25.3
Corn gluten, 60%.	---	---	---	---	---
Vegetable oil.	4.77	2.80	3.80	3.78	3.78
MOLM[1].	---	0.00	0.25	0.50	0.75
Di-calcium phosphate.	1.75	1.75	1.95	1.95	1.95
Limestone.	1.42	1.50	1.40	1.40	1.40
Vitamins and minerals mixture[2].	0.30	0.30	0.30	0.30	0.30
Salt.	0.30	0.30	0.30	0.30	0.30
Methionine[3].	---	---	0.20	0.20	0.20
Total	100	100	100	100	100
Calculated analysis (air dry basis)[4]:					
Crude protein,%.	20.02	17	17.01	17.03	17.03
ME, kcal/kg diet.	3098	3091	3128	3132	3131
C/P ratio.	154	181	183	183	183
Ca.	1.00	1.01	1.02	1.02	1.02
Av. P.	0.46	0.46	0.46	0.46	0.46

[1]Proximate composition of Moringa Oleifera leaves was cited by Esiegwu, 2019.

[2]Vitamins and minerals mixture at 0.30 % of the diet supplies the following/ kg of the diet: Vit. A, 12000 IU; Vit. D_3, 2500 IU; Vit. E, 10 mg; Vit. K_3, 3 mg; Vit B_1, 1 mg; Vit. B_2, 4 mg; Pantothenic acid, 10 mg ;Nicotinic acid, 20 mg; Folic acid, 1 mg; Biotin, 0.05 mg; Niacin, 40 mg; Vit.B_6, 3 mg; Vit B_{12}, 0.02 mg; Choline chloride, 400 mg; Mn, 62 mg; Fe, 44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01 mg.

[2]DL – Methionine: 98% feed grade (98 % Methionine).

[4]Calculated according to NRC (1994).

d. Serum samples and biochemistry:

Individual blood samples were collected from the same slaughtered birds for each dietary treatment into tubes without heparin and separated by centrifugation at 3000 rpm for 15 minutes and frozen at -20 ◦C until analysis. Serum total protein, triglyceride, lipids, cholesterol, createnine, glucose and albumin were determined using commercial kits. Also, liver enzymes including aspartate transaminase (AST) and alanine transaminase (ALT) were calorimetrically estimated.

e. Economic efficiency:

The economic efficiency of the experimental diets used in the present study was calculated from the input –

output analysis (Heady and Jensen, 1954), assuming that the other head costs were constant.

f. Statistical analysis:

Data were statistically analyzed by the completely randomized design using SPSS (2011) program and the differences among means were determined using Duncan's multiple range test (Duncan, 1955). Percentages were transformed to the corresponding arcsine values before performing statistical analysis (Snedecor and Cochran, 1982).

The model applied was:

$Y_{ij} = \mu + \alpha_i + E_{ij}$, Where:- Y_{ij}= an observation. μ = Overall mean. αi= effect of treatment (I = 1, 2, 3, 4,…..8), and E_{ij} = Random error.

RESULTS AND DISCUSSION

1. Effect of dietary low crude protein diet supplemented with different levels of Moringa Oliefera Leaves meal (MOL) on Cobb chicks performance:

a. Body weight and body weight gain:

Results concerning body weight and body weight gain of Cobb chick's fed low crude protein diet supplemented with different levels of Moringa Oliefera Leaves meal (MOL) are shown in Table 3.

Data revealed that chicks fed low crude protein (LCP, 20 and 17% during the starting and the finishing periods; negative control without supplementation, T_2) diet had the lowest body weight (BW) during the overall experimental period (35 d). At 3 weeks of age, chicks fed MOL at levels of 0.25 or 0.50% to broiler diets have the highest body weight being 789.18 and 792.34 g, respectively compared to the other treatments (positive control, negative control + 0.75% MOL and the negative control without supplementation), being 770.04, 745.12 and 706.29g, respectively.

The same trend was noticed at 5 wks. (marketing age), chicks fed 0.25 or 0.50% MOL gained the highest body weight, 1959.65 and 1953.30 g in comparison with the other groups; positive control, negative control + 0.75% MOL and the negative control without supplementation being 1801.21, 1779.39 and 1774.84g, respectively, which showed equally final body weight.

Also, body weight gain (BWG) was significantly affected by dietary low crude protein diet with the supplementation of Moringa Oleifera leaves meal (MOL) (0, 0.25, 0.50 and 0.75%). Average weight gains from 0 - 3 and 0 – 5 wks of chicks fed 0.25 and 0.50% of MOL showed the best gain, being 749.18, 752.34g and 1919.65, 1913.29g, respectively compared to the other treatments, which recorded 730.04, 705.12, 666.29g and 1761.39, 1729.39, 1734.83g in groups fed the positive control, negative control + 0.75% MOL and negative control without supplementation, respectively.

These results are in agreement with the results of Donkoe et al. (2013) who reported that body weight gain increased with increasing the levels of MOL at all ages (0 – 14, 14 - 35 and 0 – 35d). Also, Teteh et al. (2013), El-Tazi and Tibin (2014) who found that body weight gain was significantly improved with the inclusion of MOL at 5% in the broiler diet as compared to other treatment diets and Hassan et al. (2016) found that broilers fed MOL significantly increased weight gain compared to those fed un - supplemented diets.

Table 3: Body weight and body weight gain (g) of Cobb chicks fed low crude protein diets supplemented with different levels of Moringa Oliefera Leaves, MOL (Means ± S. E).

Treatments[1]	Body weight (g)		Body weight gain (g)	
	3 weeks	5 weeks	3 weeks	5 weeks
T_1	770.04 [b] ± 2.50	1801.21[b] ± 13.83	730.04 [b]± 2.50	1761.21 [b, 2, e] ± 13.83
T_2	706.29[d] ± 2.83	1774.84[b] ± 7.99	666.29[d]± 2.83	1734.83 [b] ± 7.99
T_3	789.18[a] ± 2.73	1959.65[a] ± 9.98	749.18[a] ± 2.73	1919.65 [a] ± 9.98
T_4	792.34 [a] ± 3.06	1953.30[a] ± 10.40	752.34 [a] ± 3.06	1913.29 [a] ± 10.40
T_5	745.12[c] ± 6.34	1779.39[b] ± 14.92	705.12[c] ± 6.34	1729.39 [b] ± 14.91
Sig	*	*	*	*

[1]T_1: Basal diet (Positive control), T_2: Negative control, T_3: Negative control + 0.25% MOL / kg diet, T_4: Negative control + 0.50% MOL / kg diet, T_5: Negative control + 0.75% MOL.

[2] means ± S.E. of 3 replicates/ treatment.

[3]a,b,c…….etc: Means within the same column with different superscripts are significantly different ($P < 0.05$).

b. Feed intake, feed conversion ratio and performance index:

Data of daily feed intake (FI) of Cobb chicks fed low crude protein diet supplemented with different levels of Moringa Oliefera leaves (MOL) meals is summarized in Table (4). Concerning feed intake during 0 – 3 and 0 – 5 wks. of age, chicks fed LCP diet supplemented with 0.25 or 0.50% MOL was significantly increased, being 61.63, 61.85 and 96.15, 96.24g, respectively in comparison with chicks fed the positive control diet (normal protein) or those fed low crude protein diet with or without Moringa Oliefera leaves.

The enhancement of feed intake of chicks fed MOL diets is agreement with Melesse *et al.* (2013) found that chicks fed diets containing 5% MOL significantly consumed more feed than the control diet.

Data of feed conversion ratio (FCR) was illustrated in Table (4). At three weeks of age, FCR of groups fed LCP diet supplemented with different levels of MOL 0.25, 0.50 and 0.75% MOL (1.73, 1.73 and 1.74) had similar to those fed normal protein diet (1.70).

At the marketing age (35 d) chicks fed low crude protein diets supplemented with MOL at levels of 0.25% (T_3) or 0.50% (T_4) were more efficient in converting feed into meat than the other groups (T_1, T_2 and T_5), being 1.75 and 1.76 vs. 1.82, 1.84 and 1.82, respectively.

These findings are in agreement with El - Tazi and Tibin (2014) who noted that feed intake and feed conversion ratio were improved with the supplementation of Moringa Oliefera leaves at the level of 5% in broiler diets.

The same trend was noticed in performance index (Table 4) throughout different periods (0 – 3) and (0 – 5) wks. which showed that chicks fed low crude protein diet supplemented with 0.25 or 0.50% MOL have the best performance index (45.60, 45.78) and (112, 111) compared to the other groups.

Table 4: Daily feed intake (g), feed conversion ratio (g feed / g gain) and performance index of Cobb chicks fed low crude protein diets supplemented with different levels of Moringa Oliefera Leaves, MOL (Means ± S. E).

Treatments[1]	Feed intake (g)		Feed conversion ratio (FCR, g feed / g gain)		Performance Index (PI, %)[4]	
	3 weeks	5 weeks	3 weeks	5 weeks	3 weeks	5 weeks
T_1	59.26 [b] ± 0.44	91.35 [b] ± 0.18	1.70 [b] ± 0.01	1.82 [a] ± 0.02	45.29 [a] ± 0.41	98.90 [b, 2, 3] ± 2.26
T_2	57.03 [c] ± 0.26	91.26 [b] ± 0.28	1.80 [a] ± 0.01	1.84 [a] ± 0.02	39.22 [c] ± 0.25	96.20 [c] ± 1.21
T_3	61.63 [a] ± 0.31	96.15 [a] ± 0.24	1.73 [b] ± 0.01	1.75 [b] ± 0.02	45.60 [a] ± 0.17	112.00 [a] ± 1.82
T_4	61.85 [a] ± 0.31	96.24 [a] ± 0.11	1.73 [b] ± 0.01	1.76 [b]± 0.02	45.78 [a] ± 0.22	111.00 [a] ± 1.88
T_5	58.51 [b] ± 0.53	90.16 [b] ± 0.31	1.74 [b] ± 0.01	1.82 [a] ± 0.02	42.82 [b] ± 0.54	96.74 [b] ± 1.92
Sig	*	*	*	*	*	*

[1] T_1: Basal diet (Positive control), T_2: Negative control, T_3: Negative control + 0.25% MOL / kg diet, T_4: Negative control + 0.50% MOL / kg diet, T_5: Negative control + 0.75% MOL.

[2] means ± S.E. of 3 replicates/ treatment.

[3] a,b,c……etc: Means within the same column with different superscripts are significantly different ($P < 0.05$).

[4] Performance Index (PI) = (live body weight (kg) X 100/ feed conversion.

The improvement in BWG and FCR may be due to the improvement in CP digestibility and the nutrient utilization as a result of the presence of flavonoids which react as antibacterial and antioxidant. Also, the improvement may be due to the Moringa beneficial effect on the microbial environment in the gut which might enhance digestion, absorption and utilization of nutrients

2. Effect of dietary low crude protein diet supplemented with different levels of Moringa Oliefera Leaves meal (MOL) on Cobb chicks on carcass characteristics:

The obtained results (Table 5) showed that low crude protein diet supplemented with Moringa Oliefera leaves significantly affect some carcass traits. Chicks fed low crude protein diet supplemented with 0.25 or 0.50% MOL have the highest carcass weight (1753 and 1738g) with no significant differences between them compared to 1603, 1546 and 1555g in groups fed normal crude protein diet (T_1) and negative crude protein without supplementation or with 0.75% MOL. Neither CP levels nor MOL levels had significant effect on dressing or gizzard percentages.

These results are in agreement with Ayssiwede *et al.* (2011) who reported that there were no significant differences among treatments fed the inclusion of Moringa Oliefera leaves meal.

Also, Nkukwana et al. (2014) and Hassan et al. (2016) found that addition of MOL meal at levels of 0.1 – 2.5 % to broiler diets have no significant effects on carcass weight, dressing percentage and the relative weight of liver, gizzard, heart and spleen.

Table 5. Carcass traits of Cobb chicks fed low crude protein diets supplemented with different levels of Moringa Oliefera Leaves, MOL (Means ± S. E).

Treatments[1]	Carcass traits (%)					
	Live body weight, g	Carcass weight, g	Dressing, %	Giblets, %		
				Liver	Heart	Gizzard
T_1	1804.00 ^{b} ± 27.00	1603.00 ^{b} ± 24.50	88.86 ^{b} ± 0.03	2.98 ^{b} ± 0.01	0.33 ^{2,3b} ± 0.02	1.79 ± 0.03
T_2	1733.00 ^{c} ± 19.50	1546.00 ^{c} ± 15.00	89.20 ^{a} ± 0.14	2.94 ^{b} ± 0.14	0.28 ^{c} ± 0.01	1.78 ± 0.01
T_3	1973.00 ^{a} ± 83.00	1753.00 ^{a} ± 73.00	88.85 ^{b} ± 0.04	3.13 ^{a} ±0.02	0.40^a ±0.02	1.79 ±0.03
T_4	1954.00 ^{a} ± 44.00	1738.00 ^{a} ± 40.50	88.95 ^{a} ± 0.07	3.18 ^{a} ± 0.03	0.38 ^{a} ± 0.03	1.73 ± 0.01
T_5	1747.00 ^{c} ± 21.50	1555.00 ^{c} ± 11.50	89.00 ^{a} ± 0.03	3.03 ^{ab} ± 0.03	0.31 ^{b} ± 0.03	1.74 ± 0.04
Sig	*	*	N.S	*	*	N.S

[1]T_1: Basal diet (Positive control), T_2: Negative control, T_3: Negative control + 0.25% MOL, T_4: Negative control + 0.50% MOL, T_5: Negative control + 0.75% MOL.

[2] means ± S.E. of 3 replicates/ treatment.

[3]a,b,c………etc: Means within the same column with different superscripts are significantly different ($P < 0.05$).

3. Effect of dietary low crude protein diet supplemented with different levels of Moringa Oliefera Leaves meal (MOLM) on some serum blood biochemical parameters of Cobb chicks:

Serum total protein levels was significantly increased as MOLM increased (0.25, 0.50 and 0.75% Table 6). The highest level was recorded in chicks fed 0.75% MOL supplemented to low crude protein diet with no significant differences between all MOL levels (4.73, 4.41 and 4.49 g/ dl), respectively, compared to the negative control diet (un supplemented), being 4.10 and 4.41 g/ dl, respectively, in chicks fed the normal protein diet.

Serum albumin was insignificantly affected by the supplementation. However, serum glucose level was also higher with no significant differences in groups fed low crude protein diet supplemented with 0.25% (T_3) or 0.50% (T_4) g Moringa leaves powder, being 11.41 and 12.56 mg / dl, respectively, and significantly differ with the higher level of MOL (14.02 mg/ dl) which recorded the highest level compared to the lowest levels in groups fed the normal protein diet (10.32mg/ dl) and those fed low crude protein diet without supplementation (9.87mg/ dl).

Total serum protein is a reflection of the metabolic activities related to protein synthesis or protein degradation (Hassan *et al.,* 2016). Increased total protein in chicks fed MOL diet may reflect a more intensive metabolism of protein in the chicken's organ (Melesse *et al.,* 2013) or may be due to high content of Moringa from antioxidant (Onu and Aniebo, 2011; El-Wardany *et al.,* 2012 and Asante *et al.,* 2014) which increases total blood protein by decreasing corticosterone secretion which could limit protein catabolism under heat stress conditions.

The results of serum aminotransferase activity (AST and ALT) of chicks fed low crude protein diet supplemented with different levels of Moringa Oliefera leaves showed that aspartic aminotransferase (AST) level was significantly decreased (P ≥ 0.05) by the supplementation levels (0.25, 0.50 or 0.75% of broiler diet), being 205, 202 and 210 U/ L, respectively with no significant differences between them compared to those fed normal protein diet (228 U/ L) or chicks fed low crude protein diet without MOL (232 U/ L) which recorded the highest level.

Alanine aminotransferase enzyme (ALT) did not significantly affected by MOL supplementation (11.23, 11.17 and 11.50 U/ L), respectively in groups fed 0.25, 0.50 or 0.75% compared to the normal protein diet (11.85 U/ L), but significantly differ with those fed low crude protein diet without supplementation (12.94 U/ L).

These results are in agreement with those of Hassan *et al.* (2016) and Sherwin (2003) who noted that liver released its content of AST and ALT enzymes when it damaged. Elevation of serum AST and ALT can occur with states of altered hepatocellular membrane permeability either due to circulatory hypoxia, exposure to toxins and toxemia and increased activities of AST and ALT were associated with liver and intestinal damage (Rani *et al.,* 2011).

From Table (6) data revealed that total cholesterol (82.03 and 86.95 mg/ dl) and triglycerides (80.08 and 81.95 mg / dl) were significantly decreased (P ≥ 0.05) with increasing the levels of MOL (0.25 and 0.50%) except for chicks fed the highest level of Moringa leaves powder (0.75%) recorded the highest levels of both total cholesterol and triglycerides

Table 6: Serum blood parameters of Cobb chicks fed low crude protein diets supplemented with graded levels of Moringa Oliefera Leaves, MOL (Means ± S. E).

Treatments[1]	Total Protein	Albumen	Createnine	Cholesterol	Glucose	Tri glyceride	Total lipids	AST	ALT
	---------------- g/dl---------------		------------------ mg/dl ------------------					---------- U/L ----------	
T_1	4.41 ^{a} ± 0.10	2.19 ± 0.02	0.13 ^{b} ± 0.01	87.86 ^{b} ± 3.02	10.32 ^{c} ±0.66	82.51 ^{a} ± 4.07	272.76^{b} ± 2.98	228.00 ^{a} ± 6.00	11.85^{2,3,a} ± 0.66
T_2	4.10 ^{b} ± 0.05	2.11 ± 0.10	0.11 ^{ab} ± 0.03	73.62 ^{c} ± 1.37	9.87 ^{d} ±2.26	72.88 ^{c} ± 0.74	250.24 ^{b} ± 2.39	232.00 ^{a} ±13.00	12.94 ^{a} ± 0.14
T_3	4.73 ^{a} ± 0.06	2.16 ± 0.01	0.11 ^{ab} ± 0.01	82.03^{b} ±10.87	11.41 ^{b} ±1.72	80.08^{b}± 3.91	266.89 ^{b} ± 20.76	205.00 ^{b} ± 23.00	11.23 ^{b} ± 0.94
T_4	4.41 ^{a} ± 0.14	2.19 ± 0.03	0.10 ^{a} ± 0.04	86.95 ^{b} ± 6.55	12.65^{b} ± 1.24	81.95 ^{b} ± 2.17	399.80 ^{a} ± 17.04	202.50 ^{b} ± 20.50	11.17 ^{b} ± 0.41
T_5	4.49 ^{a} ± 0.19	2.14 ± 0.09	0.18 ^{a} ± 0.00	101.65 ^{a} ± 1.45	14.02 ^{a} ± 1.68	89.29^{b} ± 1.06	408.24 ^{a} ± 2.23	210.00 ^{b} ± 2.00	11.50 ^{b} ± 1.80
Sig	*	N.S	*	*	*	*	*	*	*

[1]T_1: Basal diet (Positive control), T_2: Negative control, T_3: Negative control + 0.25% MOL, T_4: Negative control + 0.50% MOL, T_5: Negative control + 0.75% MOL.

[2] means ± S.E. of 3 replicates/ treatment.

[3]a,b,c………etc: Means within the same column with different superscripts are significantly different ($P < 0.05$).

being 101.65 and 89.29 mg/ dl, respectively compared to the positive control diet which recorded 87.86 and 82.51 mg/ dl, for total cholesterol and triglycerides, respectively.

The reduction of total cholesterol and triglycerides levels in broiler blood serum fed diet containing MOL is in agreement with the findings of Zanu *et al.* (2011) who reported hypercholesterolemia effect of MOL in broiler as Moringa contain high amount of polyphenols (Moyo *et al.,* 2012) flavonoids, alkaloids and phenolic compound possess the hypocholesterolaemic and immunity enhances effect.

The reverse effect was noticed with serum createnine which showed significantly reduction with increasing Moringa leaves powder levels up to 0.50%. These results are in agreement with Hussein and Jassim (2019) and Divya *et al.* (2014) who noted that createnine is a west molecule that is generated from protein metabolism. Reduction in createnine formation indicated retarded catabolism rate in broilers and perhaps response for non-significant reduction in chick's body weight.

4. Effect of dietary low crude protein diet supplemented with different levels of Moringa Oliefera Leaves Meal (MOL) on some intestinal morphological parameters of Cobb chicks:

The results of intestinal morphological parameters are presented in Table 7 and Figures 1, 2, 3, 4 and 5. Results showed that villi height, width and height: width ratios were increased by the supplementation of different levels of MOL (0.25 and 0.50% of low crude protein broiler diet) but not significant except in duodenum villi width and in the ration between height and width.

The highest duodenum villi height and width was noticed in chicks fed the lowest MOL level (0.25%), being 2032 and 246 µm compared to the other treatments. Reversible effect was noticed with the highest level of MOLM (0.75%) which recorded the lowest villi height and width in all intestinal sections except in ilium width which recorded the highest (207 µm) compared to the other segments.

The increased in chicks body weight is coupled with the length of duodenum and jejunum villi. In duodenum and jejunum, this increase in villi height get translated into highest villus surface area observed in 0.25 and 0.50% groups. These observations suggest improved possibility of nutrient absorption and therefor improved body weight. Our findings are supported by Tesfaye *et al.* (2013); Nkukwana *et al.* (2014 and Kkan *et al.* (2017).

5. Effect of dietary low crude protein diet supplemented with different levels of Moringa Oliefera Leaves Meal (MOL) on economic efficiency ratio:

Results of feeding cost of the experimental diets are presented in Table (8). Through our inputs and outcomes for 5 weeks old of Cobb chicks fed different levels of MOLM (0.25, 0.50 and 0.75%) in low crude protein diet (20 and 17% during starting and finishing periods). Results showed that feed cost/kg weight gain was increased with increasing level of Moringa Oliefera leaves meal. Chicks fed 0.25% MOL had the highest net revenue (27.85 L.E.) and relative economic efficiency (130%) between all MOL levels and it decreased up to this level. Also, Europeans efficiency index was significantly increased up to 0.50% MOL, being 313 and 310% in chicks fed 0.25 and 0.50% and decreased after that means that MOL should not be used to up to 0.25 or 0.50% in low crude protein diet under our experimental conditions.

Table 7: Intestinal morphology of Cobb chicks fed low crude protein diets supplemented with graded levels of Moringa Oliefera Leaves, MOL (Means ± S. E).

Treatments[1]	Duodenum villi (μm)			Jejunum villi (μm)			Ileum villi (μm)		
	Height, H	Width, W	H/ W	Height	Width	H/ W	Height	Width	H/ W
T_1	1985 ± 332	235 ^{a} ± 24	8.68 ^{b} ± 2.29	1194 ± 11.22	127 ± 43.65	10.67^{b}± 3.58	1133 ± 22.56	150 ± 310.04	15.50^{bcd,2,3}± 11.87
T_2	1864 ± 167	90 ^{b} ± 6	21.01 ^{a} ± 3.13	1109 ± 28.03	187 ± 61.40	6.08^{b}± 0.49	958 ± 23.47	151 ± 442.85	6.43^{ab}± 0.27
T_3	2032 ± 97	246 ^{a} ± 21	8.36 ^{b} ± 01.12	1459 ± 41.86	210 ± 34.15	6.80 ^{b}± 0.88	955 ± 80.02	139 ± 92.50	7.13^{bc}± 0.10
T_4	1860 ± 524	225 ^{a} ± 34	8.83 ^{b} ± 3.66	1732 ± 22.28	214 ± 5.05.75	8.14 ± 0.77	742 ± 82.99	199 ± 68.15	3.75^{a}± 0.57
T_5	1690 ± 49	169 ^{a} ± 31	10.02 ^{b} ± 0.10	1052 ± 63.31	207 ± 12.05	5.08 ± 0.01	849 ± 46.32	207 ± 10.15	4.12^{bcd}± 0.43
Sig	NS	*	*	NS	NS	NS	NS	NS	NS

[1]T_1: Basal diet (Positive control), T_2: Negative control, T_3: Negative control + 0.25% MOL, T_4: Negative control + 0.50% MOL, T_5: Negative control + 0.75% MOL.

[2] means ± S.E. of 3 replicates/ treatment.

[3]a,b,c………etc: Means within the same column with different superscripts are significantly different ($P < 0.05$).

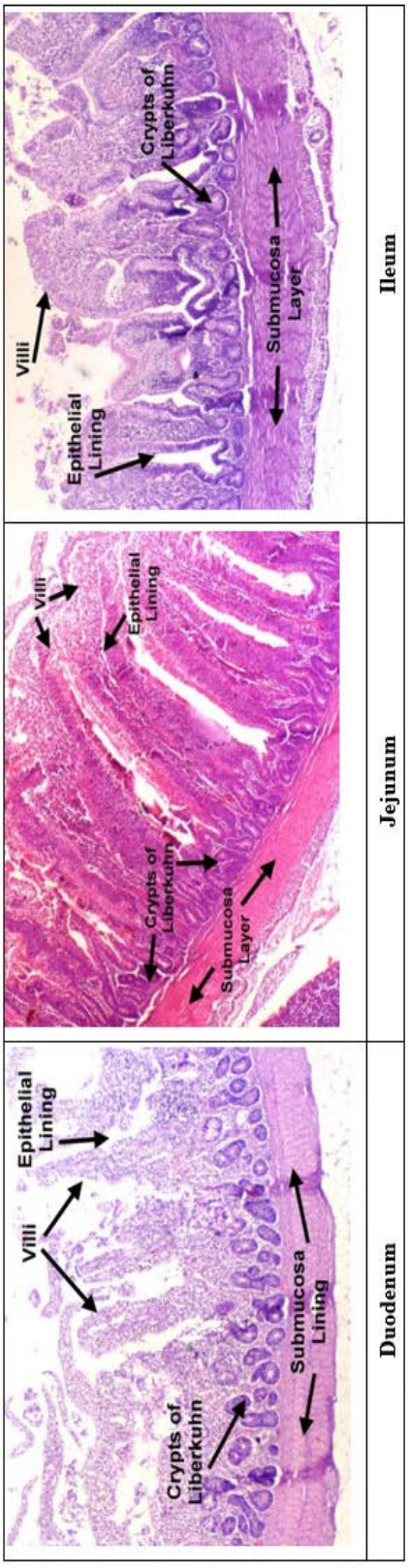

Figure 1: Different intestinal sections in chicks fed the normal crude protein diet, T_1

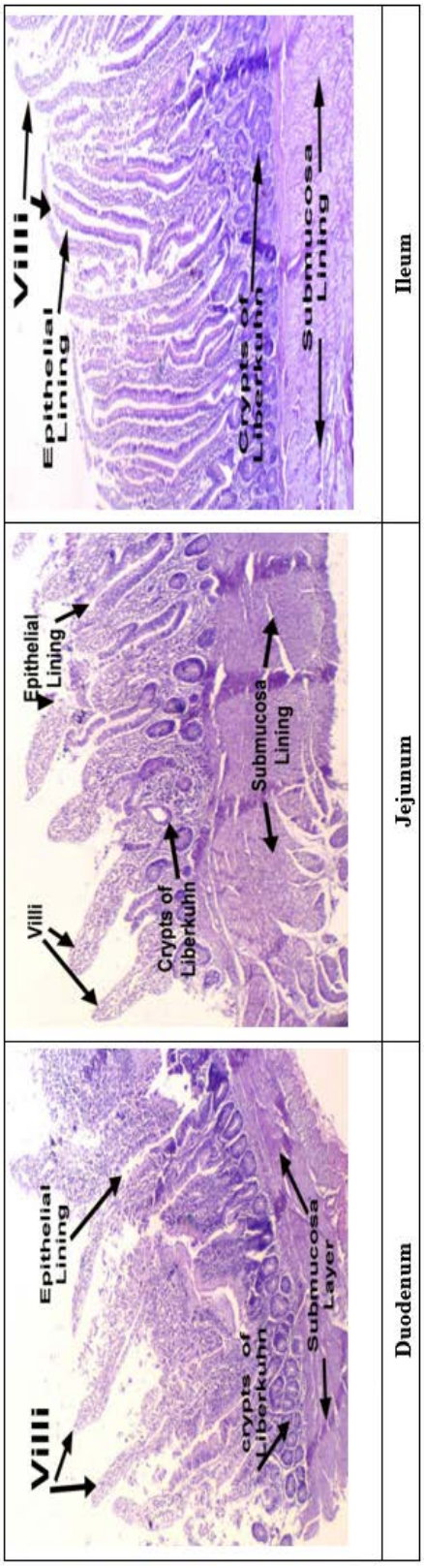

Figure 2: Different intestinal sections in chicks fed low crude protein diet without MOL, T2

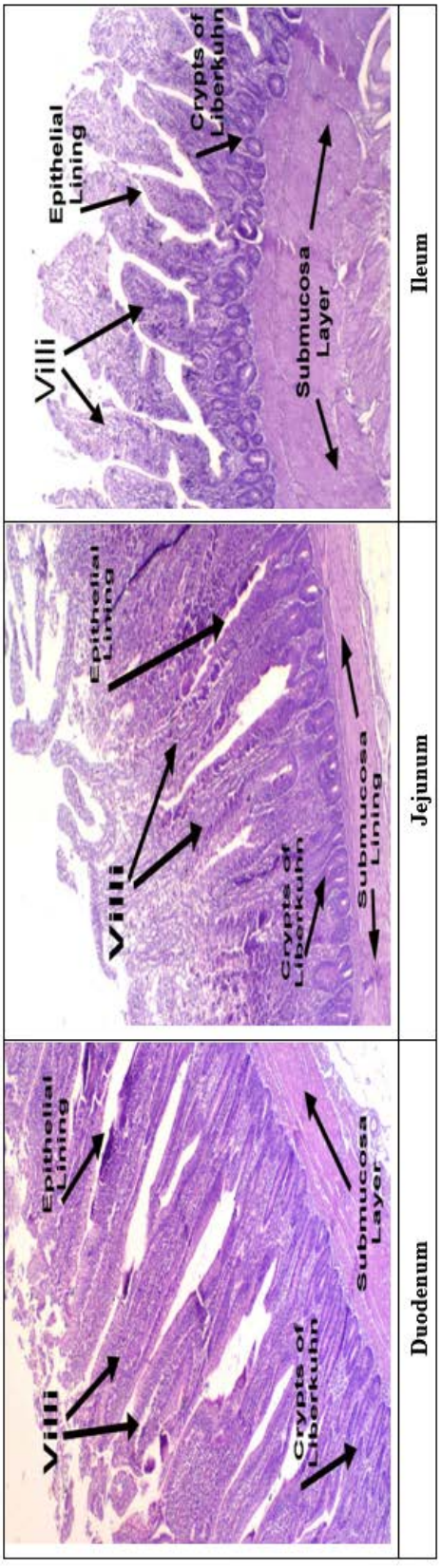

Figure 3: Different intestinal sections in chicks fed low crude protein diet +2.5g MOL, T3

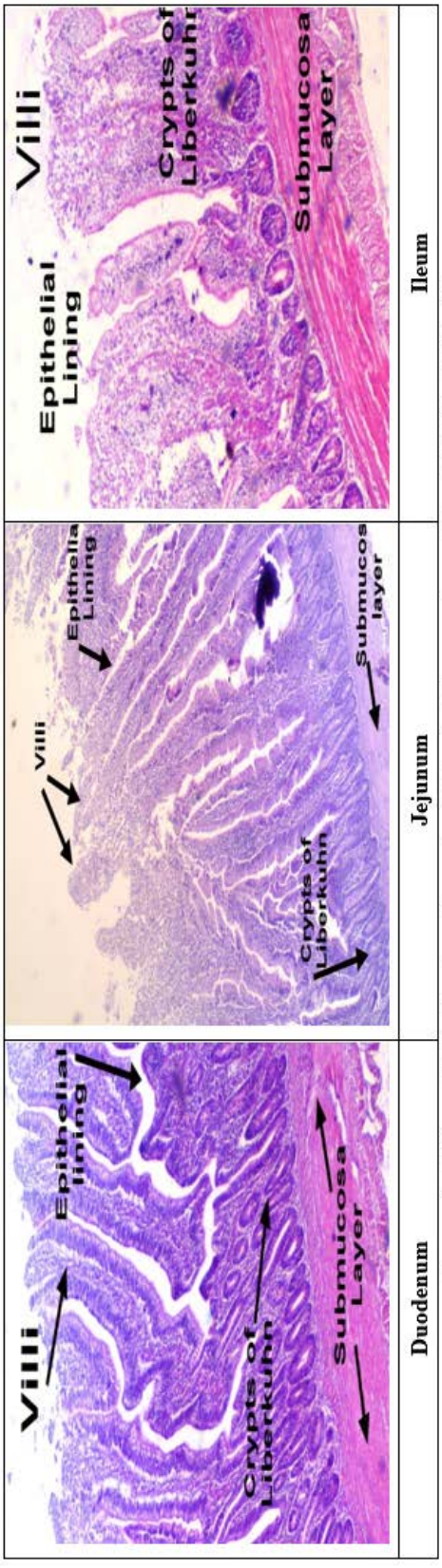

Figure 4: Different intestinal sections in chicks fed low crude protein diet +5 g MOL, T4

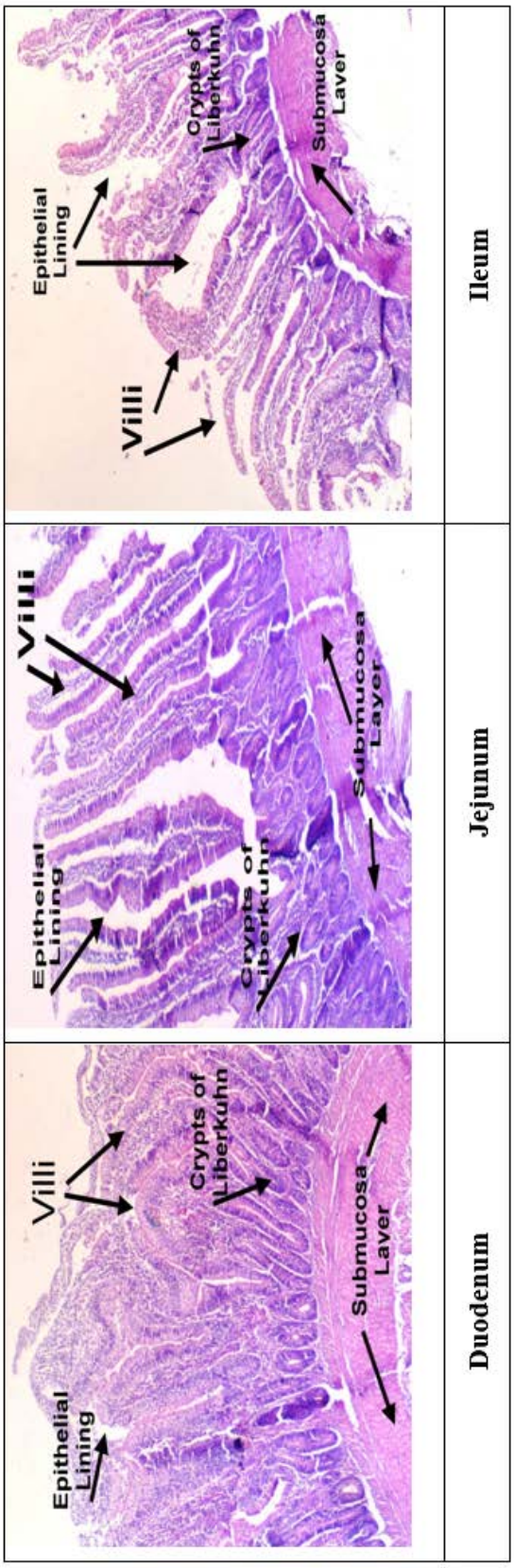

Figure 5: Different intestinal sections in chicks fed low crude protein diet +7.5g MOL, T5

Table 8

Table 8. Effect of dietary low crude protein diets supplemented with different levels of Moringa Oliefera Leaves, MOL on the economic efficiency of the experimental diets at 35 days of age.

Items	Dietary treatments[1]				
	T_1	T_2	T_3	T_4	T_5
Initial body weight, g.	40.10	40.12	40.20	40.15	40.13
Final body weight, kg.	1.80	1.77	1.96	1.95	1.78
Body weight gain, kg.	1.76	1.73	1.92	1.91	1.74
Total revenue[2], L. E.	42.24	41.54	46.08	45.84	41.76
Feed intake, kg.	3.20	3.19	3.17	3.16	3.18
Price of one kg feed, L. E.	6.05	5.45	5.75	6.05	6.35
Feed cost, L. E.	19.36	17.29	18.23	19.12	20.19
Net revenue[3], L. E.	22.88	24.25	27.85	26.72	21.57
Economical efficiency[4].	1.18	1.40	1.53	1.40	1.02
Relative economic efficiency, %.	100	119	130	119	86
European efficiency index[5].	276	269	313	310	273

[1]T1: Basal diet (Positive control), T2: Negative control, T3: Negative control + 0.25% MOL, T4: Negative control + 0.50% MOL, T5: Negative control + 0.75% MOL.

Price of one kg live body weight was 24 L.E. Price of one kg Moringa Oliefera leaves was 120.00 L.E. [2]Total revenue = live body weight gain × marketing price.

[3]Net revenue = Total revenue – Feed cost. [4]Economical efficiency = Net revenue / Feed cost.

[5]European efficiency index, EEI = (Mean body weight, kg × livability, %) / (marketing age, days × feed conversion ratio) × 100.

CONCLUSION

The obtained results in the present investigation are encouraging and indicated that supplementation of 0.25% Moringa Oliefera Leaves, MOL can be used in broiler diets with low protein level to get heaviest weight, best feed conversion, performance index, due to an increase in small intestinal absorption and activity. This, in turn, resulted in an increase in European efficiency index and economic efficiency.

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الأداء الإنتاجى والتغير الهستولوجى لكتاكيت التسمين المغذاة على علائق منخفضة البروتين بإضافة مسحوق أوراق المورينجا

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الملخص العربي

أجريت هذه التجربة لدراسة تأثير إضافة مسحوق أوراق المورينجا الجافة في علائق كتاكيت التسمين المنخفضة البروتين على كل من كفاءة النمو, صفات الذبيحة, بعض مكونات الدم، بعض التغيرات الهستولوجية فى الأمعاء والكفاءة الإقتصادية. استخدم عدد ٢٢٥ كتكوت كب غير مجنس عمر يوم – قسمت عشوائيا إلى ٥ مجموعات بكل منها ٣ مكررات (١٥ كتكوت/ مكررة), أضيف مسحوق أوراق المورينجا الجافة بالمستويات صفر، ٠,٢٥، ٠,٥٠، ٠,٧٥٪ للعليقة المنخفضة فى محتواها من البروتين (٢٠، ١٧٪ – كنترول سالب) بالمقارنة بالعليقة الطبيعية فى نسبة البروتين (٢٣، ٢٠٪ كنترول موجب) على التوالى وذلك خلال فترة البادىء (١– ٢١ يوم) وفترة الناهى (٢٢ – ٣٥ يوم).

وقد أوضحت النتائج أن الكتاكيت المغذاة على عليقة منخفضة البروتين مع إضافة مسحوق أوراق المورينجا الجافة كانت الأعلى معنويا فى وزن الجسم، معدل الزيادة فى وزن الجسم، الغذاء المستهلك يوميا وكذلك دليل الأداء. كما تحسن كل من: معدل تحويل الغذاء، دليل الكفاءة الأوروبية والكفاءة الإقتصادية, زادت نسبة التصافي (١٧٥٣، ١٧٣٨ جم) للكتاكيت نتيجة التغذية على مسحوق أوراق المورينجا بمعدل ٠,٢٥، ٠,٥٠٪ على التوالى بدون أى فروق معنوية بين باقى المستويات.

ازداد مستوى البروتين الكلى والجلوكوز بالسيرم بينما انخفض معنويا مستوى الكوليستيرول الكلى ومستوى إنزيم AST بالمقارنة بباقى المعاملات بزيادة مستوى الإضافة حتى ٠,٥٠٪. أوضح الفحص المورفولوجى لأجزاء من الأمعاء الدقيقة زيادة غير معنوية فى ارتفاع وعرض الخملات والنسبة بينهما باضافة مستويات مختلفة من مسحوق أوراق المورينجا الجافة (٠,٢٥، ٠,٥٠٪) فيما عدا فى كل من: عرض خملات الإثنى عشر والنسبة بينها وبين ارتفاعها.

بشكل عام أشارت النتائج التي تم الحصول عليها إلى أن إضافة مسحوق أوراق المورينجا الجافة إلى علائق كتاكيت التسمين المنخفضة في محتواها من البروتين بمعدل ٠,٢٥٪ أدت إلى الحصول على أثقل وزن، أفضل معدل تحويل غذائى ودليل أداء نتيجة لتحسن كفاءة الإمتصاص فى الأمعاء الدقيقة، مما أدى لزيادة دليل الكفاءة الأوروبية والكفاءة الإقتصادية تحت ظروف التجربة.

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