Acta Scientific Veterinary Sciences (ISSN: 2582-3183)

Volume 5 Issue 12 December 2023

Research Article

Effects of The Inclusion of *Moringa oleifera* (Seed and Leaves) on Low Crude Protein Diets Affect the Productive Performance, Carcass Characteristics and Blood Parameters of Broiler Chicks

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DOI: 10.31080/ASVS.2023.05.0787

Received: August 02, 2023

Published: November 20, 2023

Abstract

The high nutritional and nutraceutical qualities of Moringa Oleifera make it a valuable natural resource. The present study was designed to compare the effect of Moringa oleifera leaves meal (MOLM) and Moringa oleifera seed meal (MOSM) as an alternative to soybeans in low-protein diets on Ross chicks rations in terms of their productive responses, carcass characteristics, and blood parameters. For this purpose, a total of 210 one-day-old Ross chicks were randomly allotted to seven dietary treatments (3 replicates and 10 chicks/replicate) with different levels of Moringa oleifera leaves meal (MOLM) and Moringa oleifera seed meal (MOSM) groups: Tr1 (as control), Tr2 (control plus 2% MOLM), Tr3 (control plus 3% MOLM), Tr4 (control plus 5% MOLM), Tr5 (control plus 2% MOSM), Tr6 (control plus 3% MOSM), and Tr7 (control plus 5% MOSM as a feed replacement for soybean). These dietary treatments were administered for 7–35 days. The results obtained from the study showed that birds fed a diet containing MOSM (at the 3% level) and MOLM (at the 5% level) recorded significantly (P≤0.05) the best body weight, body weight gain, feed intake and feed conversion ratio compared with the control diet. The results showed that the diets of MOLM and MOSM had variable effects on growing broilers' digestion coefficients (P≤0.05). The findings demonstrated that dietary amounts of MOLM and MOSM impacted the carcass characteristics by increasing the live weight, slaughter weight, and carcass weight of developing broilers. Also, on biochemical parameters, the findings revealed statistically significant variation among the various treatments. Except for the A/G ratio, LDL, HDL, and total cholesterol, there were no significant differences depending on the diet's level of MOLM and MOSM. Overall, as confirmed by the present findings, the incorporation of Moringa oleifera leaves meal (MOLM) and Moringa oleifera seed meal (MOSM) as an alternative to soybeans in low-protein diets into Ross chick's diets could be proposed as a valuable strategy for the promotion of animal health and performance. More research is needed to further investigate the promising roles of Moringa oleifera in poultry nutrition.

Keywords: Moringa Oleifera; Soybeans; Carcass Characteristics; Blood Parameters

Introduction

The high expense of standard feed components in poultry diets has required the exploration of unconventional, widely available feedstuffs. Feed costs account for 60 to 70% of the entire cost of chicken production.

The impact of indigenous chickens in improving the nutritional status, income, food security, and livelihood of smallholders is significant owing to their low cost of production. Indigenous chickens contribute to the overall well-being of the households through employment creation and income generation. Therefore, any attempt to improve commercial poultry production and increase efficiency must focus on searching for alternatives and better utilization of feed resources [1]. Globally, due to the limited use of some antibiotics and their dangerous residual effects, herbal feed additives are becoming more popular in animal poultry, which may be valuable in creating medicines to improve chickens' well-being and productivity [2].

Moringa oleifera is a multipurpose tree from India and is adapted to survive in tropical regions. It is characterized by its high biomass production and its tolerance to drought conditions [3]. The Moringa is a common tree used for plantations in tropical and subtropical regions in the world, with successful cultivation happening throughout Africa [4]. The tree has many purposes, with the leaves and oilseeds currently used for human and animal consumption. In addition, there is an interest in using oil from the seed pods for biodiesel production [5]. For animal food, the seeds and leaves are a good source of protein and oil, as well as bioactive compounds like phenolics and flavonoids and phytochemicals that are good for your health, like glucosinolates and isothiocyanates [6,7]. Moreover, Moringa oleifera contains essential nutrients such as protein, vitamins A and C, and minerals like calcium and iron. Recently, researchers have investigated the utilization of Moringa oleifera as a supplementary feed source for poultry [8,9].

The protein source is one of cultivated creatures' priciest and most nutritious components. In any case, the elemental figure restricting creature execution is the amount and quality of protein. For this reason, nutritionists are working to discover conservative and ecologically neighborly ways to utilize protein-rich nourishments. The least expensive support details for monogastric have always been based on the amounts of rough protein that add up to basic amino acids (AA). The "perfect protein" demonstrates that it has changed as of late. [10-12] are being used more and more by experts in poultry nutrition. Scientists learned more about what chickens need and how easily amino acids can be digested in feed, which led to the creation of chicken diets that contain these nutrients [12-14]. This approach uses more protein by-products other than soybean meal and fish meal and more following chicken's actual amino acid requirements.

The objective of this study was to examine the effects of using Moringa oleifera leaves meal (MOLM) (2, 3, and 5%) and Moringa oleifera seed meal (MOSM) (1, 2, and 3%) as an alternative to soybeans in low-protein diets on the growth performance, carcass characteristics, digestibility coefficient, and blood parameters of broilers from 7 to 35 days old.

Materials and Methods

Birds and management

The Arish University Animal Experiments Local Ethics Committee approved all the procedures elected for this study. A total of 210 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 seven treatment groups, each consisting of 30 birds, with three replicates of 10 chicks per replicate. The chicks were kept under the same management and hygienic conditions throughout the trial.

The experimental diets 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 [15] during pre-starter (0 to 7 days), starter (7 to 21 days), and grower (21 to 35 days). The proximate composition of Moringa oleifera (leaves and seed) is provided in table 3.

The chicks were then divided into two dietary treatments based on these diets for Moringa oleifera seed meal (MOSM) and Moringa oleifera leaves meal (MOLM) groups: Tr1 (as control), Tr2 (control plus 2% MOLM), Tr3 (control plus 3% MOLM), and Tr4 (control plus 5% MOLM), Tr5 (control plus 1% MOSM), Tr6 (control plus 2% MOSM), and Tr7(control plus 3% MOSM as a feed replacement for soybean).

Growth performance and carcass traits

All birds were weighed weekly using an electronic weighing balance (range 0.1 to 1000 g). Body weight gain (BWG) was measured by subtracting the initial weight from the final weight. Weekly feed intake (FI) was recorded for all replicates and calculated by subtracting the leftover feed from the weekly feed given. The feed conversion ratio (FCR) was also calculated using the feed consumed divided by the weight gained. At the end of the experiment (day 35), nine birds per group (three birds/replicate) were randomly selected, weighed, and slaughtered to determine specific carcass characteristics, such as the carcass itself as well as the head, liver, heart, gizzard, and giblets.

Blood samples

Individual blood samples were obtained from the jugular vein of the three slaughtered birds selected from each treatment at 35 days of age. Blood samples were collected in the morning into dry, clean centrifuge tubes containing drops of heparin solution. Centrifugation at 3500 rpm. for 15 minutes separated the serum. The serum was preserved in a freezer at – 20oC until the time of analysis.

Ingredients (%)	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Yellow corn	59.91	66.44	66.34	65.44	66.84	66.84	66.44
Soybean	31.9	18	17	15	19	18	17
Corn gluten	3.6	8	8.1	9	7.6	7.6	8
Limestone	2.1	1.6	1.6	1.6	1.6	1.6	1.6
Di-calcium phosphate	1.29	2.81	2.81	2.81	2.81	2.81	2.81
* Premix (Vit. and Min.)	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3
DL. Methionine	0.1	0.15	0.15	0.15	0.15	0.15	0.15
L. Lysine	0.6	0.4	0.4	0.4	0.4	0.4	0.4
MOLM	----	2	3	5	----	----	----
MOSM	----	----	----	----	1	2	3
Total	100	100	100	100	100	100	100
Calculated Analyses							
ME Kcal/Kg	2919	3013	3003	2983	3034	3053	3063
Crude protein	23.2	20.2	20.1	20.1	20.1	20.1	20.2
Crude fiber	3	3.1	3.1	3.1	3.11	3.11	3.11
Either Extract	2.8	2.9	2.9	2.9	2.9	2.9	2
Calcium	1.4	1.6	1.6	1.6	1.6	1.6	1.6
AV. Phosphorus	0.4	0.7	0.7	0.7	0.6	0.6	0.6
L. Lysine	1.1	0.8	0.8	0.8	0.8	0.8	0.8
DL. Methionine	0.8	0.3	0.3	0.3	0.3	0.3	0.3
Determine analyses							
Protein	22.8	20	19.8	20.1	19.6	19.7	20
Ether extract	3	3.2	3.6	3.6	3.6	3.6	3.8
Crude fiber	2.2	2.7	2.5	2.6	2.7	2.7	2.7
Ash	4.6	4.4	4.2	4.2	4.3	4.3	4.4
Moisture	10.8	10.3	9.6	10.5	10.5	10.5	11.1
OM	95.4	95.5	95.8	95.7	95.6	95.6	95.5
NEF	56.5	59.3	60.3	58.9	59	59	57.8
ENRGY k/100gm	344	346	353	348	347	347	345
DM	89.1	89.6	90.4	89.7	89.4	89.4	88.8

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

* The premix (Vit. and Min.) was added at a rate of three kilograms per ton of diet and provided the following per kilogram of diet (in mg or I.U. per kilogram of diet): Vitamin A 12,000 I.U., Vitamin D3 2000 I.U., 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, Cu 10 mg, Se. 0.2 mg, I. 0.4 mg, Fe 40 mg, Zn 70 mg, and Co 0.25 mg.

Ingredients (%)	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Yellow corn	77.86	76.66	76.36	75.26	77.26	76.46	76.26
Soybean	15	13	12	10	14	13	12
Corn gluten	2.4	3.6	3.9	5	3	3.8	4
Limestone	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Di-calcium phosphate	1.8	1.8	1.8	1.8	1.8	1.8	1.8
* Premix (Vit. and Min.)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3

DL. Methionine	0.18	0.18	0.18	0.18	0.18	0.18	0.18
L. Lysine	0.51	0.51	0.51	0.51	0.51	0.51	0.51
MOLM	----	2	3	5	----	----	----
MOSM	----	----	----	----	1	2	3
Total	100	100	100	100	100	100	100
Calculated Analyses							
ME Kcal/Kg	3093	3075	3056	3047	3105	3118	3127
Crude protein	16	16.2	16.1	16.3	16.1	16.2	16.2
Crude fiber	3.3	3.3	3.3	3.3	3.4	3.4	3.4
Either Extract	2.9	2.9	2.9	2.9	3.4	3.4	3.4
Calcium	1.4	1.4	1.4	1.4	1.4	1.4	1.4
AV. Phosphorus	0.5	1	1	1	0.9	0.9	0.9
L. Lysine	0.6	0.6	0.6	0.6	0.6	0.6	0.6
DL. Methionine	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Determine analyses							
Protein	16.3	16.1	16.5	16.5	16.5	16.5	16.6
Ether extract	4.6	5	4.1	4.8	4.1	4.4	4.5
Crude fiber	2.6	2.6	2.8	2.8	2.8	2.4	2.7
Ash	4.7	4.9	4.7	4.6	4.9	4.7	4.6
Moisture	9.9	10	9.7	10.3	9.7	9.8	9.7
OM	95.2	95.1	95.2	95.3	95.2	95.3	95.4
NEF	61.6	61.2	62	60.7	61.1	62.1	60.8
ENRGY k/100gm	353	353	352	357	347	354	350
DM	90.1	90	90.2	89.6	90.3	90.2	90.3

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

*Each 3 kg of vitamin and mineral premix has the following ingredients: 300 g choline chloride; 50 g zinc; 4 g copper; 0.3 g iodine; 30 g iron; 0.1 g selenium; 60 g manganese; 0.1 g cobalt; and carrier CaCO3 to 3000 g.

Blood samples were analyzed using commercial kits to measure the serum levels of various components, including total protein [16], albumin [17], glucose [18], total lipids [19], LDL, HDL [20], cholesterol [21], and liver enzymatic activity (AST and ALT) using commercially available kits [22]. The albumin value was subtracted from the total protein value to calculate the globulin value. Furthermore, the albumin and globulin data were used to determine the albumin/globulin ratio (A/G).

Digestibility trial and chemical analysis

The collection period extended to five days, during which excreta was quantitatively collected every 24 hours, and daily intake was recorded. The excreta were cleaned from feathers and led, then weighed and dried in an oven at 60oC for 36 hours. Samples were then finally ground and placed in screw-top glasses until analysis. Four digestibility trials were performed at 35 days of age. In each trial, nine male birds were housed individually, caged, and fed the experimental diets for three days to allow the birds to become acclimated to the cages. Trial diets were provided to them for three days to help the birds become used to their new surroundings. Chemical analyses were performed on the examined diets and excreta using AOAC [23] procedures for dry matter, ash, crude protein, ether extract, crude fiber, and nitrogen-free extract.

Statistical analysis

The data were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of the statistical analysis system institute [24], while comparisons among means were made by Duncan's Multiple Range Test [25]. A value of $P < 0.05$ was considered statistically significant.

Results and Discussion

Chemical composition on dry matter of *Moringa oleifera* leaves

The result of the proximate composition of MOLM and MOSM (Table 3). Regarding the dry matter, it was in MOLM and MOSM (91.5 and 92.99%), crude fiber (17 and 18.2%), crude protein (28 and 30.9), ether extract (10.6 and 26.7%), ash (12 and 6%), and Nitrogen-free extract (23.9 and 11.19), respectively. Dye and De [26] found that the DM of Moringa oleifera leaves meal (MOLM) was 93.630.01, as well as lower percentages of ash (7.96), CP (22.23), CF (6.77), EE (6.41), and NFE (40.28). The gross energy value was recorded as 14.790 MJ/kg. The findings of this study indicate that the nutritional composition of MOLM exhibits variations according to geographical location and maybe the stage at which the leaves are harvested.

Nutrients	On DM basis	
	Moringa oliefera leaves	*Moringa oliefera* seed
Dry matter	91.5	92.99
Organic matter	79.5	86.9
Protein	28	30.9
Ether Extract	10.6	26.7
Crude fiber	17	18.2
Ash	12	6
NFE	23.9	11.19
Moisture	8.5	7.1

Table 3: Proximate composition of *Moringa oleifera* (leaves and seed) (on dry matter basis %).

Chicks performance

Changes in live body weight during the experiment revealed that the chicks fed rations containing MOSM (at the 3% level) had the highest final body weight, followed by those fed rations of MOLM (at the 5% level), with significant differences among the supplemented groups compared to the control diet (Table 4). Total gain was the highest for chicks fed both MOSM (at the 3% level) and MOLM (at the 5% level), with the control diet being 2496, 2483, and 2226 g, respectively.

According to feed intake, the diet containing 3% MOSM had the maximum feed consumption, followed by 2% MOLM, then the control diet, and those differences were statistically significant (P<0.05) at all four-time intervals. Feed intake of tested rations expressed as dry matter intake (DMI) was 3566, 3502, and 3321 g for lambs fed diets with 3% MOSM, 2% MOLM, and the control diet, respectively. The results showed that the best feed conversion (P < 0.05) was recorded for 5% MOLM, followed by all levels of MOSM and then control, whereas the worst was noted for 2% MOLM.

These findings agree with the literature data from Adeyemi., *et al*. [27], who found that adding Moringa leaves meal to a 5% broiler diet increased the birds' growth performance and feed conversion ratio. Similarly, Mikhail., *et al*. [28] 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. Following our investigation, Granella., *et al*. [29] reported that, compared to the control group and other treatments, birds fed MOSM level 0.2% had significantly (P < 0.05) higher feed intake values throughout the 7-42-day period. In contrast, Paguia., *et al*. [30] showed that adding 0.20, 0.30, 0.40, and 0.50% MOSM to broiler diets had no significant (P < 0.05) impact on FCR values.

Digestion coefficients

Adding MOLM and MOSM had variable effects on the digestion coefficient of nutrients in the diets. Some digestion coefficient nutrients, such as CP, CF, EE, and NEF, showed significant differences among the diets. In contrast, dry matter showed no significant differences based on the diet's level of MOLM and MOSM (Table 5).

These results agree with those obtained by Rabie and El-Maaty, [31], indicating that the digestion coefficients of DM, OM, CP, EE, CF, and NFE were significantly depressed in quail birds when dietary CP was decreased from 24-20% CP. The positive response on growth performance as a result, Moringa contains active substances such as Ceresin and beta-sitosterol, which enhance the production of immune cells such as T-cells, B-cells, and lymphocyte cells and improve their functions, which play an essential role in

Items	Control (0%)	*Moringa oliefera* leaves meal, (%)			*Moringa oliefera* Seed meal, (%)			Sign.
		2%	3%	5%	1%	2%	3%	
Live body weight (g)								
Initial weight at 7 day	176	180	175	178	173	177	178	
Weight at 14 day	320^{a} ± 3.75	294^{b} ± 9.16	307^{ab} ± 3.33	294^{b} ± 9.16	311^{ab} ± 11.49	291^{bc}±12.88	309^{ab}±4.91	*
Weight at 21 day	542^{c} ± 16.49	560^{bc} ± 17.32	575^{b} ±35.29	582^{b} ±43.77	629^{a} ± 16.10	608^{ab} ± 32.96	607^{ab}±12.73	*
Weight at 28 day	1088^{b} ± 22.46	1084^{b} ± 86.88	1137^{a} ± 65.53	1067^{bc} ± 75.64	1082^{b} ± 19.15	1027^{c} ± 38.98	1024^{c} ± 00	*
Weight at 35 day	2402^{b} ± 55.18	2521^{ab} ±125.03	2461^{ab} ±219.35	2661^{a} ± 102.32	2300^{c} ± 77.88	2315^{c} ± 92.59	2674^{a} ±105.07	*
Body Weight gain (g)								
7-14 day	145^{a} ± 3.48	113^{b} ± 5.60	132^{ab} ± 5.10	116^{b} ± 9.72	138^{a} ± 11.98	113^{b} ± 13.05	131^{ab} ± 6.07	*
14-21 day	222^{c} ± 15.14	267^{bc} ± 16.66	268^{bc} ± 33.27	289^{abc} ±36.49	318^{a} ± 33.27	318^{a} ± 36.49	299^{b} ± 15.14	*
21-28 day	546^{ab} ± 30.36	523^{b} ± 69.76	562^{a} ± 44.65	484^{bc} ± 36.35	453^{c} ± 10.81	418^{d}± 40.01	416^{d} ± 12.73	*
28-35 day	1314^{ab} ± 33.99	1437^{ab} ± 57.97	1324^{ab} ±266.32	1594a ±177.94	1218^{c} ± 73.45	1288^{bc} ±125.77	1650^{ab} ±105.07	*
7-35 day	2226^{abc} ±56.56	2341^{abc} ±108.51	2286^{abc} ±222.3	2483^{a} ± 145.01	2127^{c} ± 65.40	2137^{c} ± 90.18	2496 ^{a} ±113.19	*
Feed intake (g)								
7-14 day	180^{a} ± 0.00	191^{a} ± 17.82	155^{b} ± 6.69	172ab ± 27.60	167^{ab} ± 5.75	134.83^{cd} ± 4.41	135^{cd} ± 4.41	*
14-21 day	475^{cd} ± 13.50	644^{a} ± 30.78	583^{ab} ± 43.28	494^{bc} ± 30.19	568^{ab} ± 18.83	558.20^{ab} ± 31.95	621^{a} ± 72.86	*
21-28 day	988^{a} ± 13.50	952^{ab} ± 73.05	814^{bc} ± 45.17	805^{bc} ± 40.00	921^{ab}±1.15	899^{ab}±34.29	886^{ab}±14.28	*
28-35 day	1672^{abc} ±83.38	1714^{ab} ± 71.26	1899^{a} ± 103.17	1760^{ab} ± 67.68	1703^{abc}±37.03	1697^{abc}±67.87	1919^{a}±87.26	*
7-35 day	3321^{abc} ± 85.31	3502^{a} ± 83.38	3231^{b} ± 105.86	2565^{c} ± 67.21	3359^{ab}±37.00	3276^{b}±68.25	3566^{a}±90.81	*
Feed conversion ratio (g. feed/g. gain)								
7-14 day	1.24^{bc} ± 0.02	1.68^{a} ± 0.09	1.17^{c} ± 0.01	1.47^{ab} ± 0.20	1.22^{ab} ± 0.10	1.23^{ab} ± 0.20	1.03^{b} ± 0.02	*
14-21 day	2.15^{ab} ± 0.20	2.44^{a} ± 0.24	2.20^{ab} ± 0.12	1.74^{bc} ± 0.11	1.27^{cd} ± 0.03	1.64^{bc} ± 0.01	1.71^{abc} ± 0.04	*
21-28 day	1.8^{b} ± 0.11	1.8b ± 0.12	1.4^{bc} ± 0.04	1.6^{b} ± 0.09	2.0^{ab} ± 0.04	2.1^{a} ± 0.15	2.1^{a} ± 0.09	*
28-35 day	1.2^{b} ± 0.08	1.2^{b} ± 0.05	1.5^{a} ± 0.19	1.1^{b} ± 0.09	1.4^{a} ± 0.10	1.3^{ab} ± 0.07	1.2^{b} ± 0.03	*
7-35 day	1.6^{ab} ± 0.05	1.76^{a} ± 0.02	1.63^{ab} ± 0.06	1.44^{c} ± 0.03	1.56^{b} ± 0.06	1.56^{b} ± 0.02	1.55^{b} ± 0.02	*

Table 4: Effect of dietary levels of *Moringa oleifera* leaves meal (MOLM) and *Moringa oleifera* seed meal (MOSM) on performance of broiler chicks.

a,b,c d Different superscripted means within the same row differ considerably (P<0.05). NS: Not significant (p≥0.05), *: Significant (p < 0.05) enhancing immunity and raising the efficiency of the work of internal organs. In addition to the above, Moringa contains linolenic acid, which promotes growth hormone secretion. Moringa's success may be due to bioactive chemicals, minerals including calcium, magnesium, phosphorus, amino acids (lysine and methionine), and some vitamins. Several studies have linked these chemicals to boost broiler growth Voemesse., *et al*. [32] and El-Kashef [33]. Also, the high content of Moringa leaves from vitamins C and A [34,35] and flavonoids act as powerful antioxidants and can eliminate the adverse effects of free radicals. Also, Moringa contains organosulfur compounds and amides/alkaloids. These compounds have a substantial effect on pathogenic bacteria, such as *E. coli* [36,37]. In addition to anti-inflammatory and immunomodulatory properties [38]. These chemicals may improve the intestinal microbial balance [39,40], enhancing digestive efficiency, stimulating digestive enzymes such as lipase and amylase, and immune condition. This improves the digestibility of crude protein and increases body weight, which explains the increased FCR. Researchers reported similar results [41,42].

Items	Control (0%)	*Moringa oliefera* Leaves meal, (%)			*Moringa oliefera* Seed meal, (%)			Sign.
		2%	3%	5%	1%	2%	3%	
DM	90.10 ± 0.10	90.00 ± 0.00	90.23 ± 0.12	89.66 ± 0.33	90.30 ± 0.17	90.20 ± 0.10	90.30 ± 0.17	NS
CP	80.70^{b} ± 0.35	83.83^{a} ± 0.44	84.63^{a} ± 0.23	84.20^{a} ± 0.53	73.92^{c} ± 0.17	73.29^{c} ± 0.31	73.76^{c} ± 0.42	*
EE	76.74^{a} ± 2.52	77.47^{a} ± 0.75	73.17^{ab} ± 2.49	72.03^{ab} ± 2.20	70.74^{ab} ± 2.59	65.91^{b} ± 2.81	73.94^{ab} ± 1.06	*
CF	23.77^{b} ± 3.40	22.55^{b} ± 3.64	25.64^{ab} ± 5.10	29.33^{a} ± 1.70	26.97^{ab} ± 3.86	13.73^{c} ± 3.32	25.90^{ab} ± 4.62	*
NFE	74.20^{b} ± 0.10	74.18^{b} ± 0.29	74.37^{b} ± 0.15	74.54^{b} ± 0.59	82.83^{a} ± 1.01	84.10^{a} ± 0.59	83.16^{a} ± 0.73	*

Table 5: Effect of dietary *Moringa oleifera* leaves meal (MOLM) *and Moringa oleifera* seed meal (MOSM) levels on digestion coefficient (%) of growing broiler

a, b, c Different superscripted means within the same row differ considerably ($P < 0.05$). NS: Not significant ($p \geq 0.05$), *: Significant ($p < 0.05$).

Carcass characteristics

The carcass yield, such as live weight, slaughter weight, and carcass weight were significantly influenced by the dietary changes induced by the addition of increasing levels of MOLM and MOSM in chicks' rations (Table 6). At the same time, the different diets did not significantly affect each carcass's weight, heart, gizzard, gut, liver, or giblets ($P \geq 0.05$). Although the addition of MOSM indicated a decrease in liver weight, it also indicated a decrease in the dressing for levels of MOLM and MOSM. However, this difference was not considered statistically significant ($P \geq 0.05$).

Our results follow the finding by Ochi., *et al*. [43], who evaluated the effects of MOSP on the performance and carcass characteristics of broilers (0.5, 1.0, and 2.0%) and found that the addition of different levels of MOSP showed no significant effects ($P > 0.05$) on dressing percentage, liver weight, and heart weight. Our results disagree with Elbushra., *et al*. [44], who determined the effect of dietary MOS supplementation on broiler chickens (0, 0.5, 1, and 2%/kg) where there were highly significant differences ($P \leq 0.01$) between the treatments for rib back, wings, carcass shrinkage, and hind back percent; also there were significantly different ($P \leq 0.05$) between the treatments for warm carcass, cold carcass, left side, right side and all values of the parts and cuts except dressing empty body and muscles percent. In addition to improving carcass characteristics, Moringa leaves have also been demonstrated to possess antibacterial and antioxidant qualities that help enhance poultry health [45].

Blood constituents

Both MOLM and MOSM additives significantly increased total protein, albumin, globulin, total lipids, and ALT (Table 7). There were no significant differences ($P > 0.05$) for the A/G ratio, LDL, HDL, and total cholesterol. These results are within normal ranges for all serum contents [45]. Total protein reflects the animal's nutritional status and positively correlates with dietary protein intake [46].

These results agree with Yang., *et al*. [47], who determined the effect of *Moringa oliefera* stem (MOS) meal in ducks, and they found that the total protein and albumin were increased in MOS diets during 0 to 4 weeks of age, but decreased during 5 to 9 weeks of age. Also, the same results were archived by Wahab., *et al*. [48]

Items	Control (0%)	*Moringa oliefera* leaves meal, (%)			*Moringa oliefera Seed* meal, (%)			Sign.
		2%	3%	5%	1%	2%	3%	
Live weight, g	1902.67^{b}±30.18	2058^{ab}±41.76	1968.67^{ab}±65.67	2067.67^{a}±33.84	2064^{a}±62.51	2058^{a}±41.76	1969^{ab}±65.67	*
SLAU. weight, g	1859.33^{c}±29.67	1970^{ab}±58.59	1891.67^{b}±54.94	1996.67^{a}±23.33	1960^{ab}±60.00	1983^{a}±57.83	1861^{c}±29.24	*
Carcass weight, g	1793.33^{b}±52.06	1853.33^{ab}±63.59	1763.33^{c}±53.64	1890.00^{a}±20.81	1834^{ab}±33.01	1780^{b}±41.63	1750^{c}±28.87	*
Head (g)	49.33 ± 1.45	51.67 ± 0.88	50.33 ± 0.88	53.00 ± 0.58	50.67 ± 1.20	52.33 ± 1.20	51.67 ± 0.88	NS
Heart (g)	8.67 ± 0.88	9.67 ± 0.33	9.67 ± 0.33	10.33 ± 0.33	9.33 ± 0.67	10.0 ± 0.58	9.67 ± 0.33	NS
Gizzard (g)	53.33 ± 1.67	53.33 ± 1.67	53.33 ± 1.67	53.33 ± 1.67	53.33 ± 1.67	53.33 ± 1.67	53.33 ± 1.67	NS
Gut (g)	143.0 ± 0.58	143.00 ± 0.58	143.00 ± 0.58	143.00 ± 0.58	143.0 ± 0.58	143.0 ± 0.58	143.0 ± 0.58	NS
Liver (g)	45.33 ± 2.60	44.67 ± 2.91	46.67 ± 4.26	44.67 ± 2.91	44.0 ± 2.31	44.67 ± 2.91	44.33 ± 2.60	NS
Lungs (g)	9.33 ± 0.33	9.33 ± 0.33	9.33 ± 0.33	9.33 ± 0.33	9.33 ± 0.33	9.0 ± 0.58	9.33 ± 0.33	NS
Giblets (g)	107.33 ± 3.84	107.67^{a} ± 3.71	109.67 ± 5.24	108.33 ± 3.33	106.67 ± 3.28	108.0 ± 3.61	107.33 ± 3.38	NS
Dressing, %	94.25±2.59	90.01±1.46	89.59 ±0.40	91.45 ±1.62	88.92±1.06	86.51±1.65	89.00±1.81	NS

Table 6: Effect of dietary *Moringa oliefera* leaves meal (MOLM) and *Moringa oliefera* seed meal (MOSM) levels on carcass characteristics of growing broiler.

a, b, c Different superscripted means within the same row differ considerably (P < 0.05). NS: Not significant (p ≥ 0.05), *: Significant (p < 0.05).

Items	Control (0%)	*Moringa oliefera* leaves meal, (%)			*Moringa oliefera Seed* meal, (%)			Sign.
		2%	3%	5%	1%	2%	3%	
Total protein (g/dl)	2.73^{b} ± 0.07	2.90^{ab} ± 0.08	3.03^{a} ± 0.08	2.64^{b} ± 0.27	2.95^{a} ± 0.02	2.70^{b} ± 0.03	2.62^{b} ± 0.27	*
Albumin (g/ dl)	1.38^{b} ± 0.11	1.59^{ab} ± 0.07	1.57^{ab} ± 0.04	1.61^{ab} ± 0.16	1.42^{b} ± 0.04	1.63^{a} ± 0.17	1.36^{b} ± 0.06	*
Globulin (g/dl)	1.35^{ab} ± 0.03	1.30^{ab} ± 0.06	1.42^{ab} ± 0.15	1.03^{b} ± 0.11	1.53^{a} ± 0.01	1.07^{c} ± 0.20	1.14^{c} ± 0.09	*
A/G ratio	1.00 ± 0.11	0.82 ± 0.03	0.91 ± 0.11	0.63 ± 0.00	1.08 ± 0.03	0.70 ± 0.22	0.83 ± 0.02	NS
Total LIPIDS (mg/dl)	383.18^{a} ± 2.00	366.15^{ab} ± 9.29	368.81^{ab} ± 6.75	358.47^{b} ± 6.74	376.49^{a} ± 2.67	358.47^{b} ± 6.74	373.20^{ab} ± 2.98	*
Glucose (mg/dl)	174.66^{b} ± 1.66	138.00^{c} ± 12.52	117.66^{d} ± 0.33	112.00^{d} ± 2.00	233.00^{a} ± 0	125.00^{c} ± 0	116.33^{d} ± 6.69	*
LDL (mg/dl)	92.00 ± 0	85.56 ± 2.35	80.49 ± 1.36	94.13 ± 7.54	99.19 ± 3.49	90.26 ± 2.98	90.23 ± 5.12	NS
HDL (mg/dl)	91.07 ± 2.36	91.14 ± 2.30	87.91 ± 3.81	86.78 ± 2.73	91.07 ± 2.36	85.26 ± 1.67	88.68 ± 0.86	NS
Total cholesterol (mg/dl)	183.3 ± 2.36	176.7 ± 4.46	168.4 ± 2.87	180.9 ± 5.70	190.3 ± 3.93	175.5 ± 4.12	178.9 ± 5.16	NS
ALT (U/l)	18.33^{a} ± 0.66	18.33^{a}± 1.20	15.33^{b} ± 0.66	18.66^{a} ± 0.33	18.33^{a} ± 1.20	18.00^{a}± 1.00	17.00^{ab} ± 1.15	*

Table 7: Effect of dietary levels of *Moringa oliefera* leaves meal (MOLM) *Moringa oliefera* seed meal (MOSM) levels on the blood biochemical parameters of broiler chicks.

a, b, c Different superscripted means within the same row differ considerably (P<0.05). NS: Not significant (p≥0.05), *: Significant (p < 0.05).

when studying the effect of feeding different dietary levels of MOSP on Cobb 500 chicks where found that blood serum of total cholesterol and LDL were lower in chicken fed 0.75% MOSP (with and without) enzyme compared to the control and the other dietary levels of MOSP, also values of AST were lower in broilers fed MOSP at 0.75%.

The results of this study differ from those of Yakubu., *et al*. [49], and Azeem., *et al*. [50]. Others, like glucose, LDL, and ALT, showed substantial variations based on the amount of MOLM in the diet. Similarly, Makanjuola., *et al*. [51] 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 compared to the control group. Conversely, According to Moustafa, [52], feeding quail birds diets supplemented with 0.2, 0.4, and 0.6% germination-added Moringa oleifera seed had no apparent effect on plasma glucose levels.

Conclusion

Under the conditions of the present study, using MOLM or MOSM (as natural alternatives to protein) at different levels in the diet of Ross chicks appeared to show better performance than chicks in the control diet. Substituting traditional proteins with Moringa Oleifera (seed and leaves) in chicks' diets can offer additional benefits, such as increased carcass yield and improved blood metabolites, without adversely affecting performance indexes.

Acknowledgements

The authors thank the staff of the research farm in the Department of Animal and Poultry Production, Faculty of Agriculture, Al-Arish University, Egypt, for their support and assistance during the experiment.

Conflict of Interest

Declare if any financial interest or any conflict of interest exists.

Bibliography

1. Khan Rifat Ullah., *et al*. "Potential applications of Moringa oleifera in poultry health and production as alternative to antibiotics: a review". *Antibiotics* 10.12 (2021): 1540.
2. Mahfuz SU., *et al*. "Inclusion of probiotic on chicken performance and immunity: A review". *International Journal of Poultry Science* 16.9 (2017): 328-335.
3. Melesse Aberra., *et al*. "Evaluating the nutritive values and in vitro degradability characteristics of leaves, seeds and seedpods from Moringa stenopetala". *Journal of the Science of Food and Agriculture* 89.2 (2009): 281-287.
4. Busani L., *et al*. "West Nile virus circulation in Veneto region in 2008-2009". *Epidemiology and Infection* 139.6 (2011): 818-825.
5. Azad S Kamran., *et al*. "Effect of zinc concentration and source on performance, tissue mineral status, activity of superoxide dismutase enzyme and lipid peroxidation of meat in broiler chickens". *Animal Production Science* 58.10 (2017): 1837-1846.
6. Maldini Mariateresa., *et al*. "Moringa oleifera: study of phenolics and glucosinolates by mass spectrometry". *Journal of Mass Spectrometry* 49.9 (2014): 900-910.
7. Premi Monica and HK Sharma. "Effect of extraction conditions on the bioactive compounds from Moringa oleifera (PKM 1) seeds and their identification using LC–MS". *Journal of Food Measurement and Characterization* 11 (2017): 213-225.
8. El-Kashef Mohamed M., *et al*. "Effect of using (moringa oleifera) seed meal on performance of growing quail birds". *Sinai Journal of Applied Sciences* 6.3 (2017): 343-352.
9. Khan Rifat Ullah., *et al*. "*Moringa oleifera*: a natural gift-A review". *Journal of Pharmacy and Nutrition Sciences* 7.1 (2017): 13-19.
10. Baker David H and Yanming Han. "Ideal amino acid profile for chicks during the first three weeks posthatching". *Poultry Science* 73.9 (1994): 1441-1447.
11. Emmert Jason L and David H Baker. "Use of the ideal protein concept for precision formulation of amino acid levels in broiler diets". *Journal of Applied Poultry Research* 6.4 (1997): 462-470.
12. Baker David H. "Ideal amino acid patterns for broiler chicks". *Amino Acids in Animal Nutrition*. Wallingford UK: CABI Publishing (2003): 223-235.
13. NRC "Nutrient Requirements of Poultry Nith Revised Edition National Academy Press". *Washington DC* 10 (1994): 2114.
14. Degussa. "Feedback Special P- 6a/MP/03/96". *Degussa AG Hanau, Germany* (1996).

15. NRC "Nutrient requirements of poultry". *Washington, DC, National Academic Press) DC* 10 (1994).

16. Gornall Allan G., *et al*. "Determination of serum proteins by means of the biuret reaction". *Journal of Biological Chemistry* 177.2 (1949): 751-766.

17. Doumas Basil T., *et al*. "Albumin standards and the measurement of serum albumin with bromcresol green". *Clinica Chimica Acta* 31.1 (1971): 87-96.

18. Trinder Paul. "Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor". *Annals of clinical Biochemistry* 6.1 (1969): 24-27.

19. Zöllner Nepomuk and Katharina Kirsch. "Über die quantitative Bestimmung von Lipoiden (Mikromethode) mittels der vielen natürlichen Lipoiden (allen bekannten Plasmalipoiden) gemeinsamen Sulfophosphovanillin-Reaktion". *Zeitschrift für die gesamte experimentelle Medizin* 135 (1962): 545-561.

20. Wieland Heinrich and Dietrich Seidel. "A simple specific method for precipitation of low-density lipoproteins". *Journal of Lipid Research* 24.7 (1983): 904-909.

21. Richmond W. "Preparation and properties of a cholesterol oxidase from Nocardia sp. and its application to the enzymatic assay of total cholesterol in serum". *Clinical Chemistry* 19.12 (1973): 1350-1356.

22. Reitman Stanley and Sam Frankel. "A colorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminases". *American Journal of Clinical Pathology* 28.1 (1957): 56-63.

23. AOAC. "Association of official Analytical Chemists. Official methods of Analysis". (17th Edition.). A Publication of the Ass". *official Anal. Chem., Washington, D.C* (2002): 52-157.

24. SAS Institute Inc. "SAS/STAT user's guide: Version 9.4 edition". Cary, NC: SAS Institute Inc (2010).

25. Duncan DB. "Multiple ranges and multiple F-test". *Biometrics* 11 (1955): 1-42.

26. Dey Avijit and Partha Sarathi De. "Influence of Moringa oleifera leaves as a functional feed additive on the growth performance, carcass characteristics and serum lipid profile of broiler chicken". *Indian Journal of Animal Research* 47.5 (2013): 449-452.

27. Adeyemo GO., *et al*. "Evaluation of *Moringa oleifera* leaf meal as feed additive on the performance, carcass characteristics and haematology of broiler chickens". *Nigerian Journal of Animal Science and Technology* 1.1 (2018): 32-39.

28. Mikhail WZ., *et al*. "Effect of feeding Moringa oleifera leaf meal with or without enzyme on the performance and carcass characteristics of broiler chicks". *Plant Archives* 20.1 (2020): 3381-3388.

29. Granella Suian José., *et al*. "An approach to recent applications of *Moringa oleifera* in the agricultural and biofuel industries". *South African Journal of Botany* 137 (2021): 110-116.

30. Paguia Hermogenes M., *et al*. "Utilization and evaluation of *Moringa oleifera L*. as poultry feeds". *APCBEE Procedia* 8 (2014): 343-347.

31. Rabie MH and El-Maaty HMA. "Growth performance of Japanese quail as affected by dietary protein level and enzyme supplementation". *Asian Journal of Animal and Veterinary Advances* 10.2 (2015): 74-85.

32. Voemesse K., *et al*. "Effect of Moringa oleifera leaf meal on growth performance and blood parameters of egg type chicken during juvenile growth". *International Journal of Poultry Science* 17.4 (2018): 154-159.

33. El-Kashef and Mohamed Mostafa. "Impact of using *moringa oleifera* leaves meal in growing rabbit diets on productive performance, carcass traits and blood biochemical changes under heat-stress conditions". *Egyptian Journal of Rabbit Science* 32.2 (2022): 141-162.

34. Ferreira Paulo Michel Pinheiro., *et al*. "Moringa oleifera: bioactive compounds and nutritional potential". *Revista de Nutrição* 21 (2008): 431-437.

35. Konmy Basile BS., *et al*. "A review on phytochemistry and pharmacology of Moringa oleifera leaves (Moringaceae)". *Journal of Pharmacognosy and Phytochemistry* 5.5 (2016): 325-330.

36. Makkar HPS., *et al*. "Bioactivity of phytochemicals in some lesser-known plants and their effects and potential applications in livestock and aquaculture production systems". *Animal* 1.9 (2007): 1371-1391.

37. Soltan YA., *et al*. "Comparative effects of *Moringa oleifera* root bark and monensin supplementations on ruminal fermentation, nutrient digestibility and growth performance of growing lambs". *Animal Feed Science and Technology* 235 (2018): 189-201.

38. Khatab AE., *et al*. "Evaluation of the effects of cypermethrin on female reproductive function by using rabbit model and of the protective role of Chinese propolis". *Biomedical and Environmental Sciences* 29.10 (2016): 762-766.

39. Lee KW., *et al*. "Effects of dietary essential oil components on growth performance, digestive enzymes and lipid metabolism in female broiler chickens". *British Poultry Science* 44.3 (2003): 450-457.

40. Boyraz Nuh and Musa Özcan. "Inhibition of phytopathogenic fungi by essential oil, hydrosol, ground material and extract of summer savory (*Satureja hortensis* L.) growing wild in Turkey". *International Journal of Food Microbiology* 107.3 (2006): 238-242.

41. UR Rahman Sajid., *et al*. "*In vivo* effects of Allium cepa L. on the selected gut microflora and intestinal histomorphology in broiler". *Acta Histochemica* 119.5 (2017): 446-450.

42. Ochi EB., *et al*. "Effect of Moringa (Moringa oleifera Lam) seeds on the performance and carcass characteristics of broiler chickens". *Journal of Natural Sciences Research* 5.8 (2015): 66-73.

43. Elbushra Baraa FI., *et al*. "Effect of dietary moringa (*Moringa oleifera*) seeds inclusion on performance of broiler chickens". *Egyptian Journal of Nutrition and Feeds* 22.2 (2019): 157-166.

44. Leung H., *et al*. "Responses of broiler chickens to Eimeria challenge when fed a nucleotide-rich yeast extract". *Poultry Science* 98.4 (2019): 1622-1633.

45. Boyd James W. "The interpretation of serum biochemistry test results in domestic animals". *Veterinary Clinical Pathology* 13.2 (1984): 7-14.

46. Kumar N., *et al*. "Effect of different levels of dietary protein and energy on growth of male buffalo calves". *Indian Journal of Animal Sciences* (1981).

47. Yang SL., *et al*. "Effects of feeding diets with processed Moringa oleifera stem meal on growth and laying performance, and immunological and antioxidant activities in laying ducks". *Poultry Science* 99.7 (2020): 3445-3451.

48. Wahab Osama AF Abdel., *et al*. "Effect of Moringa oleifera seeds powder on performance and immunity of broiler chicks". *AIMS Agriculture and Food* 5.4 (2020): 896-910.

49. Yakubu B., *et al*. "Effects of substituting groundnut cake with moringa (*Moringa oleifera*) leaf meal on growth performance, carcass yield and haematological profile of weaner rabbits". *Journal of Science, Technology and Education* 2.1 (2013): 77-84.

50. Azeem S. *et al*. "Effects of Antibiotics on Growth Performance, Immune Response, and Intestinal Microflora of Broilers". *Pakistan Journal of Zoology* 54.6 (2022): 2629.

51. Makanjuola BA., *et al*. "Effect of Moringa oleifera leaf meal as a substitute for antibiotics on the performance and blood parameters of broiler chickens". *Livestock Research for Rural Development* 26.8 (2014): 144.

52. Moustafa Kout-Elkloub Moustafa. "Effect of using germinated moringa oleifera seeds on Japanese quail growth performance". *Egyptian Poultry Science Journal* 36.2 (2016): 561-571.