British Journal of Poultry Sciences 10 (2): 15-26, 2021
ISSN 1995-901X

DOI: 10.5829/idosi.bjps.2021.15.26

Response of Japanese Quail to Diets Containing Different Levels of Moringa Dry Leaves

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Abstract: A total number of 375 one day old of unsexed Japanese quail chicks (JQC) were randomly divided into five groups, each subdivided into 5 equal replicates to investigate the impact of feeding JQC on diets containing Moringa dry leaves (MDL) at different levels on their productive performance, carcass characteristics and some blood parameters. Five levels of MDL (0, 2, 4, 6 and 8 g/ kg diet) were added to experimental diets for 7 weeks. Feeding period divided into two stages: first stage considered as starter period (0-21 days), but the second stage considered as grower and finisher period (22-49 days). Results showed that, MDL had high contents of crude protein, crude fat and ash. All tested diets were almost iso-caloric and iso-nitrogenous. Treatments had no effect ($P>0.05$) on productive performance, however, inclusion MDL at 8 g/ kg diet recorded the best values of final weight and improved feed conversion. Blood plasma biochemistry indices as liver, kidney and, lipid profiles, we aimed to further illustrate how different levels of supplementary MOL affects the performance and health of chicks. Dressing percentages significantly ($P<0.05$) decreased by inclusion MDL at 2 g/ kg diet compared to control, however the others levels of MDL supplementation were not significantly ($P>0.05$) affected comparing to control. Also, carcass cuts were not affected. It can be concluded that incorporation MDL at different levels from 2 to 8 g/ kg diet in JQC realized an improving in its productive performance without occurring any adverse effect on their blood constituents with decreasing in low density lipoprotein cholesterol (LDL-C). It had no adverse effect on their carcass characteristics. In addition to it improved total body weight gain, feed conversion and decreased both feed intake and LDL-C.

Key words: Moringa dry leaves · Japanese quail · Productive performance · Carcass characteristics · Blood parameters

INTRODUCTION

Using antibiotic in poultry industry as growth promoters has been banned because of harmful effects on human health. This was noticed by the development of microbial resistance to these products [1]. So, herbs; spices; and various plant extracts considered to be natural products that consumers would accept have received increased attention as possible feed additives such as antibiotic growth promoter replacements following their ban by the European Union in 2006 [2].

Feed additives are important materials that can improve the efficiency of feed utilization and animal performance. However, the use of chemical products especially those of antibiotics and hormones may cause unfavorable effects. Using medicinal herbs and plants (MH and P) with humans has been known since the old civilization. Inversely many synthesized chemicals caused many hazards to animals, plants and human [3].

Medicinal plants contain several phytochemicals and bioactive compounds such as trace metal ions, alkaloids, vitamins, carotenoids, fats, polyphenols, carbohydrates and proteins, which are useful for long-term health [4].

Several alternatives to these growth promoters have been proposed such as organic acids and medicinal plants as natural feed additives are now recently used in poultry diet to enhance the performance of the immune response of birds [5].

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Moringa oleifera lam is commonly named as the miracle tree or Horseradish tree; it has an impressive range of medicinal uses with high nutritive value throughout the world [6]. Several biological properties ascribed to different parts of this tree, the leaves have been reported to be a valuable source of -carotene, vitamins (B complex, C, D and K) beside some important macro and micro-elements as calcium, potassium, zinc, iron, copper and selenium [7]. In the same time moringa leaves are free from anti-nutritional factors, e.g. phenols, tannins, saponins and has high contents of iron (Up to 58.2 mg/100 g DM), carotene (up to 40 mg/100 g DM) and vitamin C (Up to 0.92 g/100 g DM) as described by [8].

The Moringa leaves are highly nutritious and contain significant quantities of vitamins (A, B and C), calcium, iron, phosphorus and protein [9]. Furthermore, heavy metals such as mercury, arsenic and cadmium which are potentially toxic are absent from the leaves of *M. oleifera*, thus making their incorporation into poultry diet safe [10].

Moringa leaves contain some anti-nutritional factors; negligible amounts of tannins (1.4%); total phenols (3.4%); nitrate (0.5 mmol/100g); oxalate (4.1%); saponin (1.2%) and phytase (3.1%) as noted by [11]. Chinwe and Isitua [12] noted that Moringa leaves have positive effects on hematological parameters of rabbits. It effectively prevent morphological changes and oxidative damage in human and animals by enhancing the activeity of antioxidant enzymes, reducing the intensity of lipid peroxidation and inhibiting generation of free radicals [13, 14]. Furthermore, it has been used to promote the immune system against microorganism's infection [15].

Elwy *et al.* [16] revealed that blood aspartate transaminase (AST) and urea decreased in the MS treatment. Both triglycerides and total cholesterol were reduced with no significant deference's in alanine aminotransferase (ALT), albumin, total protein, globulin and A/G ratio among dietary treatment.

Moringa is concentrated in nutrients and in the raw form, it seems to reduce the activity of pathogenic bacteria and moulds and improves the digestibility of other foods, thus helping chickens to express their natural genetic potential [17].

Moringa oleifera leaves are widely used traditionally for its antimicrobial abilities [18]. It also contents sufficient quantities of carotene, ascorbic acid, iron, methionine and cystine [8].

Replacing antibiotic growth promoters with Moringa leaf powder of 0.1 or 0.05% or Moringa fruit powder of 0.1 or 0.05% has beneficial effects on the growth performance and carcass yield of broiler chicken [19]. Also, Banjo [20] noted that inclusion of four levels (i.e., 0%, 1%, 2% and 3%) of Moringa oleifera leaf meal significantly enhanced weight gain. however; it not significantly increased both feed intake and feed conversion.

So, the present work aimed to investigate the impact of inclusion moringa dry leaves at different levels (0, 2, 4, 6 and 8 g/ kg diet) in JQC diets on their productive performance, carcass characteristics and blood constituents.

MATERIALS AND METHODS

Experimental Design and Management: This study was carried out at El-Nubaria Experimental and Production Station at El-Imam Malik Village in Co-operation work between Animal Production and Animal Reproduction & Artificial Insemination Departments, National research Centre, 33 El-Bohouth Street, P.O: 12622, Dokki, Giza, Egypt.

A total number of 375 unsexed JQC one day age were randomly housed in battery cages for 49 days that divided into two stages, first stage (starter period) lasted for 21 days, followed by, the second stage (grower and finisher period) lasted for 28 days.

Chicks were distributed into five equal experimental groups; each containing 75 chicks that divided into 5 equal replicates each contained 15 chicks.

Five experimental diets were formulated to contain 0, 2, 4, 6 and 8 g/ kg Experimental diets were offered free choice (*ad lib*).

Feed Intake and Feed Conversion Efficiency: Feed intake expressed as (DMI and CPI, g) or (GEI and MEI, kcal for each replicate per treatment group was calculated. Also, feed conversion that expressed as (total grams of DMI or CPI/ total g gain) or (total kilo calories of GEI or MEI/ total g gain) per each treatment group were also calculated at different periods includes (0-21 days), (22-49 days) or over the entire period (0-49 days) for each treatment group.

Carcass Traits: At the end of feeding trial, five representative birds from each treatment were randomly chosen to determine the carcass parameters according to [21]. Birds were performed according to the Islamic rules. Animals were weighed just before slaughter, slaughter weight (SW) was recorded and as well as after complete bleeding. Total edible offal's (Giblets) included liver, gizzard, heart and testes were weighed.

Also non edible offals included blood; feather; head; legs and full digestive tract were weighed and recorded. Hot carcass weight (CW_1) and hot carcass weight included giblets (CW_2) were recorded to calculate dressing percentages as the following:

Dressing percentages (DP1) = CW_1 / S
Dressing percentages (DP2) = CW_2 / SW

Analytical Procedures: Chemical analyses of ingredients were analyzed according to AOAC [22] methods.

Blood samples were collected from the slaughtered birds and centrifuged at 4000 r.p.m for 20 min., for preparation of blood plasma. Plasma kept frozen at -18°C for subsequent analysis. Plasma total protein was determined according to Witt and Trendelenburg [23]; albumin according to Tietz [24]; triglycerides [25]; total cholesterol according to Pisani *et al* [26]; plasma Glutamic Pyruvic Transaminase (GPT) activities were determined as described by Reitman and Frankel [27] and Harold [28]; creatinine [29]; high-density lipoprotein-cholesterol (HDL-C) was estimated according to the Assmann [30] and low density lipoprotein-cholesterol (LDL-C) was determined as method described by McNamara *et al*. [31] using commercial kits. On the other hand, globulin and albumin: globulin ratio (A: G ratio) were calculated.

Tables of NRC [32] were used to calculate metabolizable energy (ME) of feed ingredients. Meanwhile, metabolizable energy (kcal/ kg DM) of moringa dry leaves calculated according to Scott *et al.* [33] using the following equation:

ME = 53 + 38 (CP % + 2.25 x EE % + 1.1 x NFE %).

Chemical analysis of ingredients presented in Table [1], meanwhile calculated experimental ration are shown in Table [2].

Calculated Data: Gross energy (Kcal/ Kg DM) calculated according to Blaxter [34]. Each g CP= 5.65 Kcal, g EE= 9.40 Kcal and g (CF & NFE) = 4.15 Kcal.

Statistical Analysis: Data collected of live body weights, feed intake, feed conversion, carcass characteristics and blood constituents were subjected to statistical analysis as one way analysis of variance according to SPSS [35]. Duncan's Multiple Range Test Duncan, [36] was used to separate means when the dietary treatment effect was significant according to the following model:

$Y_{ij} = \mu + T_i + e_{ij}$ Where: Y_{ij} = observation. μ = overall mean. T_i = effect of experimental rations for i = 1–5, 1 = Basal diet ($D_{1)}$ contained 0 moringa dry leaves (MDL), Meanwhile D_2, D_3, D_4 and D_5 contained 2, 4, 6 and 8 g MDL/ kg diet, respectively.
e_{ij} = the experimental error.

RESULTS AND DISCUSSION

Chemical composition of Moringa dry leaves (MDL) presented in Table [1] showed that MDL had high contents of crude protein (31.55%), crude fat (8.25%) and ash (15.07%). These results comparable with those noted by [37-39] who found that dry Moringa leaves contained (31.68% crude protein); (8.78% crude fat) and (14.88% ash). Also, in another studies carried out on un-extracted or dry Moringa leaves, values ranged between 23.63-30.29%, 2.23-6.50 and 7.13-13.34% were recorded for crude protein, crude fat and ash, respectively [18].

Chemical Analysis of the Experimental Diets: Chemical composition of different starter experimental diets illustrated in Table [2] showed that diets were almost iso-caloric and iso- nitrogenous. All experimental diets were similar crude protein (CP) that ranged between 23.02 to 23.08%, crude fiber (CF) 3.97 to 3.99%, ether extract (EE) 2.98 to 3.03%, nitrogen-free extract (NFE) 64.55 to 64.75% and ash 5.28 to 5.36% on DM basis, respectively. Calculated gross energy (GE) and metabolizable energy (ME) of experimental diets was ranged from 4433 to 4434 and 2754 to 2761 kcal/ Kg DM for GE and ME, respectively. Meanwhile, chemical composition of different grower and finisher experimental diets that presented in the same Table [2] showed that diets were also iso-caloric-iso- nitrogenous.

Experimental diets contained the same portions of Moringa MDL (0, 0.20, 0.40, 0.60 and 0.80%) were almost similar in their contents of crude protein (CP) that varied from 21.29 to 21.35%, crude fiber (CF) 3.95 to 3.97%, ether extract (EE) 3.17 to 3.22%, nitrogen-free extract (NFE) 66.30 to 66.50% and ash 5.09 to 5.17% on DM basis, respectively. On the other hand, calculated gross energy (GE) and metabolizable energy (ME) of experimental diets was ranged from 4424 to 4425 and 2777 to 2782 kcal/ Kg DM for GE and ME, respectively.

Productive Performance of Experimental Groups: Data of productive performance throughout the first stage (starter period) presented in Table (3) mentioned that,

Table 1: Chemical analysis (%) of feed ingredients

Item	Yellow corn	Protein concentrations	Soybean meal (SBM)	Moringa dry leaves (MDL)
Moisture	7.35	3.05	6.39	8.72
Chemical analysis on DM basis:				
OM	98.61	92.72	94.84	84.93
CP	9.22	45.00	44.00	31.55
CF	4.07	2.96	4.41	6.25
EE	4.51	1.49	0.77	8.25
NFE	80.81	43.27	45.66	38.88
Ash	1.39	7.28	5.16	15.07
Gross energy (kcal/kg DM)[1]	4467	4601	4636	4431
Metabolizable energy (kcal/kg DM)[2]	2896	3500	2440	3582

[1]Gross energy (kcal/kg DM): calculated according to Blaxter [34].

[2]Metabolizable energy (kcal/kg DM) : calculated according to Scott *et al.* [33]

Table 2: Composition and calculated of chemical analysis of the experimental diets

	Experimental diets (g MDL/ kg diet)				
	D_1	D_2	D_3	D_4	D_5
	0	2 g	4 g	6 g	8 g
Ingredients	MDL	MDL	MDL	MDL	MDL
1-Starter diets					
Yellow corn	57.75	Basal diet	Basal diet	Basal diet	Basal diet
Protein concentrations	10.00	+	+	+	+
Soybean meal	30.00	2g MDL / kg diet	4g MDL / kg diet	6g MDL / kg diet	8g MDL / kg diet
Limestone	2.00				
Di-calcium phosphate	0.25				
Calculated of chemical analysis:					
Moisture	6.53	6.53	6.53	6.54	6.54
Chemical analysis on DM basis:					
Organic matter (OM)	94.72	94.70	94.68	94.67	94.64
Crude protein (CP)	23.02	23.03	23.06	23.08	23.08
Crude fiber (CF)	3.97	3.98	3.94	3.99	3.98
Ether extract (EE)	2.98	3.00	3.02	3.02	3.03
Nitrogen-free extract (NFE)	64.75	64.69	64.58	64.58	64.55
Ash	5.28	5.30	5.33	5.33	5.36
Gross energy (kcal/kg DM)	4433	4433	4434	4434	4433
Metabolizable energy (kcal/kg DM)	2754	2756	2758	2760	2761
2-grower and finisher diets					
Yellow corn	62.75	Basal diet	Basal diet	Basal diet	Basal diet
Protein concentrations	10.00	+	+	+	+
Soybean meal	25.00	2g MDL / kg diet	4g MDL / kg diet	6g MDL / kg diet	8g MDL / kg diet
Limestone	2.00				
Di-calcium phosphate	0.25				
Calculated of chemical analysis:					
Moisture	6.58	6.57	6.57	6.58	6.59
Chemical analysis on DM basis:					
Organic matter (OM)	94.91	94.88	94.87	94.86	94.83
Crude protein (CP)	21.29	21.30	21.33	21.34	21.35
Crude fiber (CF)	3.95	3.96	3.96	3.97	3.96
Ether extract (EE)	3.17	3.18	3.19	3.20	3.22
Nitrogen-free extract (NFE)	66.50	66.44	66.39	66.35	66.30
Ash	5.09	5.12	5.13	5.14	5.17
Gross energy (kcal/kg DM)	4425	4424	4425	4425	4425
Metabolizable energy (kcal/kg DM)	2777	2779	2780	2782	2784

Table 3: Productive performance of Japanese quail throughout the first stage (starter) period (0-21 days)

	Experimental diets (g MDL/ kg diet)					
	D_1	D_2	D_3	D_4	D_5	
	0	2 g	4 g	6 g	8 g	
Item	MDL	MDL	MDL	MDL	MDL	SEM
Number of chicks	75	75	75	75	75	---
Duration period			21 days			
Initial weight, g (IW)	253	254	256	253	255	1.02
Final weight, g (FW)	2143	2001	1796	1858	2198	72.96
Total body weight gain, g (TBWG)	1890	1747	1540	1605	1943	73.18
Total feed intake in average expressed as:						
DM, g	5086^{a}	4918^{ab}	4704^{bc}	4759^{abc}	4525^{c}	60.11
CP, g	1171^{a}	1133^{ab}	1085^{bc}	1098^{abc}	1044^{c}	13.70
GE, kcal	22546^{a}	21801^{ab}	20853^{bc}	21101^{abc}	20059^{c}	266.4
ME, kcal	14007^{a}	13554^{ab}	12974^{bc}	13135^{abc}	12494^{c}	164.2
Feed conversion expressed as (total g intake of DM or CP / total g gain)						
DM	2.69^{ab}	2.82^{ab}	3.05^{b}	2.97^{ab}	2.33^{a}	0.10
CP	0.62^{ab}	0.65^{ab}	0.70^{b}	0.68^{ab}	0.54^{a}	0.02
Feed conversion expressed as (total kcal intake of GE or ME / total g gain)						
GE	11.93^{ab}	12.48^{ab}	13.54^{b}	13.15^{ab}	10.32^{a}	0.46
ME	7.41^{ab}	7.76^{ab}	8.42^{b}	8.18^{ab}	6.43^{a}	0.29

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).

SEM: Standard error of mean.

DM= dry matter. CP= crude protein. GE= gross energy. ME= metabolizable energy.

Table 4: Productive performance of Japanese quail throughout the second stage (grower and finisher) period (22-49 days)

	Experimental diets (g MDL/ kg diet)					
	D_1	D_2	D_3	D_4	D_5	
	0	2 g	4 g	6 g	8 g	
Item	MDL	MDL	MDL	MDL	MDL	SEM
Number of chicks	75	75	75	75	75	---
Duration period			28 days			
Initial weight, g (IW)	2143	2001	1796	1858	2198	72.96
Final weight, g (FW)	3550	3610	3677	3657	3842	89.23
Total body weight gain, g (TBWG)	1407	1609	1881	1799	1644	73.96
Total feed intake in average expressed as:						
DM, g	7311	7346	7348	7366	7256	69.57
CP, g	1557	1565	1567	1572	1549	14.78
GE, kcal	32351	32499	32515	32595	32108	307.8
ME, kcal	20303	20415	20427	20492	20201	193.2
Feed conversion expressed as (total g intake of DM or CP / total g gain)						
DM	5.20^{b}	4.57^{ab}	3.91^{a}	4.09^{ab}	4.41^{ab}	0.17
CP	1.11^{b}	0.97^{ab}	0.83^{a}	0.87^{ab}	0.94^{ab}	0.04
Feed conversion expressed as (total kcal intake of GE or ME / total g gain)						
GE	22.99^{b}	20.20^{ab}	17.29^{a}	18.12^{ab}	19.53^{ab}	0.77
ME	14.43^{b}	12.69^{ab}	10.86^{a}	11.39^{ab}	12.29^{ab}	0.48

a and b: Means in the same row having different superscripts differ significantly (P<0.05).

SEM: Standard error of mean. DM= dry matter.

CP= crude protein. GE= gross energy. ME= metabolizable energy

incorporation MDL at 0.80% in significant increased (P>0.05) both final weight (FW) and total body weight gain (TBWG) in comparison with the all other diets. However, it significantly (P<0.05) decreased feed intake that expressed as (DM, CP, g) or (GE and ME, kcal) compared to control (D_1) and 0.20% MDL (D2) diets. Meanwhile, in significant (P<0.05) decreasing in feed intake occurred in birds fed 0.80% MDL (D_5) compared to D_3 and D_4 that contained 0.40 or 0.6% MDL in their diets, respectively. On the other hand, feed conversion was in

significant (P<0.05) improved by inclusion MDL at 0.80% compared to the control diets (D_1) and other diets (D_2 and D_3), however, it was significantly (P<0.05) comparing with birds received 0.40% MDL containing diet (D_4).

Data of productive performance throughout the second stage (grower and finisher) period (22-49 days) are shown in Table [4] cleared that, incorporation MDL at different levels insignificant increased (P>0.05) both final weight (FW) and total body weight gain (TBWG) comparing to control diet.

In generally dietary treatments had no significant effect (P<0.05) on feed intake, however, chicks received 0.80% MDL containing diet (D_5) recorded the lowest values of feed intake that expressed as DM and CP, g) or (GE and ME, Kcal).

Feed conversion was significantly (P<0.05) improved by inclusion MDL at 0.40% (D_3) in comparison with the control diets (D_1), however the other levels of supplementation from MDL (D_2, D_4 and D_5) in significantly (P<0.05) improved feed conversion comparing with the control (D_1).

Generally dietary treatments had no significant effect (P>0.05) on productive performance includes (total body weight gain, final weight, feed intake and feed conversion) as shown in Table [5]. Also, data of productive performance throughout over the entire period (0-49 days) showed that, incorporation MDL at different levels insignificant (P<0.05) increased both final weight (FW) and total body weight gain (TBWG) in comparison with the control diet (D_1).

Dietary treatments had no significant effect (P>0.05) on feed intake, however, quail chicks received 0.80% MDL containing diet (D_5) recorded the lowest values of feed intake that expressed as DM and CP, g) or (GE and ME, Kcal).

Inclusion MDL at 0.80% (D_5) insignificantly (P<0.05) improved feed conversion comparing with the control diets (D_1) and the other supplementation of MDL (D_2, D_3 and D_4). These results coincided with the finding of Ebenebe *et al.* [40] who reported that, chicks fed on Moringa leaves based diets performed significantly (P<0.05) better than the birds of control group in term of higher weight gain and better feed conversion. This improvement in body weight gain and feed conversion may be related to rich content of nutrients in moringa leaves [41] and antimicrobial properties of Moringa [42]. Also the present results were in agreement with those tabulated by [5] who found that body weight at four and six weeks of age was significantly (P<0.01) higher in quail chicks that received basal diet with 0.20, 0.40 or 0.60% Moringa oleifera leaf meal (MOLM) as compared to the control group. Also, they noted that final BW and BWG of quail chicks at the last interval days 7-42 d of age in MOLM treated groups were significantly higher compared to control group.

The improving in weight gain of birds fed on 0.2, 0.4 and 0.6% MOLM compared to control group could be attributed to high digestibility of Moringa leaves [43] which could improve absorption of nutrients. This effect of MOLM leads to higher daily weight gain and improve feed conversion ratio in diets that contained MDL groups compared to control group. Also the present results are in harmony with the results obtained by Banjo [20] who mentioned that the inclusion of Moringa oleifera leaf meal with 1, 2 and 3% levels in the diet of the broilers significantly (P<0.05) enhanced their weight gain at 1% level which was significantly higher than the control. Also, David *et al.* [19] noted that incorporation 0.1% or 0.05% Moringa leaf powder significantly (P<0.05) improved growth performance of broiler chicken compared to the control. Furthermore, the body weight gain of chicks was increased with the increasing percentages of Moringa leaf during the finisher and total periods. In addition to, Dey and De [44] found that adding 0.25 or 0.40 % MOLM in broiler diets realized a significant (P<0.01) improvement in body weight compared to control. Also, Teteh *et al.* [45] showed that overall chick weights and daily BWG increased significantly with age (P<0.05) when used 1 and 2 % MOLM compared to the control group. In contrast, Makanjuola *et al.* [46] observed that adding MOLM at 0.2, 0.4 and 0.6% to the diets lasted 28 days, had no adverse effect on final weight and body weight gain in broiler chicken. Also, Paguia *et al.* [47] noticed that incorporation 0.20, 0.30, 0.40 and 0.50% moringa leaves in broiler diets did not (P<0.05) significantly influence the broilers body weight and body weight gain; feed consumption and feed conversion. On the other hand, EL-Moustafa *et al.* [5] noted that at the interval of 15-28 day, 29-42day and 7-42day of age with quail chicks received 0.40 and 0.60% MOLM were significantly higher in feed consumption as compared to control and 0.2% MOLM. This may be attributed to birds fed MOLM based diets adequately utilized the nutrients they consumed. In addition for that, Karthivashan *et al.* [48] observed that incorporation 0, 0.5, 1.0 and 1.5% of moringa leaves extracts, gave significantly better feed conversion compared to the control. While, 1.5% gave the best feed conversion and lowest feed intake compared to other treatments in broiler diets. Meanwhile, Teteh *et al.* [45] noted that inclusion moringa leaves at 1 and 2% did not influence feed intake and FCR.

Table 5: Productive performance of Japanese quail throughout over the entire period (0-49 days)

	Experimental diets (g MDL/ kg diet)					
	D_1	D_2	D_3	D_4	D_5	
	0	2 g	4 g	6 g	8 g	
Item	MDL	DL	MDL	MDL	MDL	SEM
Number of chicks	75	75	75	75	75	-
Duration period			49 days			
Initial weight, g (IW)	253	254	256	253	255	1.02
Final weight, g (FW)	3550	3610	3677	3657	3842	89.23
Total body weight gain, g (TBWG)	3297	3356	3421	3404	3587	89.33
Total feed intake in average expressed as:						
DM, g	12398	12264	12053	12126	11783	122.3
CP, g	2747	2719	2676	2693	2618	26.92
GE, kcal	54911	54317	53383	53718	52187	541.7
ME, kcal	34293	33947	33375	33601	32674	336.8
Feed conversion expressed as (total g intake of DM or CP / total g gain)						
DM	3.76	3.65	3.52	3.56	3.28	0.08
CP	0.83	0.81	0.78	0.79	0.73	0.02
Feed conversion expressed as (total kcal intake of GE or ME / total g gain)						
GE	16.65	16.19	15.60	15.78	14.55	0.36
ME	10.40	10.12	9.76	9.87	9.11	0.23

SEM: Standard error of mean.

DM= dry matter. CP= crude protein. GE= gross energy. ME= metabolizable energy.

Table 6: Blood parameters of the experimental groups

	Experimental diets (g MDL/ kg diet)					
	D_1	D_2	D_3	D_4	D_5	
	0	2 g	4 g	6 g	8 g	
Item	MDL	MDL	MDL	MDL	MDL	SEM
Total protein (g/ dl)	6.30	6.37	6.43	6.50	6.53	0.08
Albumin (g/ dl)	2.77[a]	2.32[b]	2.64[a]	2.73[a]	2.59[a]	0.05
Globulin (g/ dl)	3.53	4.05	3.79	3.77	3.94	0.10
Albumin: globulin ratio	0.78[a]	0.57[b]	0.70[ab]	0.72[ab]	0.66[ab]	0.03
Triglycerides (mg/dl)	120.00	87.00	85.00	83.00	82.00	6.88
Total cholesterol (mg/dl)	140.00	138.00	131.00	137.00	133.00	4.04
HDL-C (mg/dl)	88.00	98.00	90.00	94.00	91.00	4.32
LDL-C (mg/dl)	28.00	22.60	24.00	26.40	25.60	2.01
GPT (U/I)	8.33	10.67	8.67	9.33	9.67	0.43
Creatinine (mg/dl)	0.77	0.53	0.60	0.63	0.67	0.05

a and b: Means in the same row having different superscripts differ significantly (P<0.05).

SEM: Standard error of mean.

HDL-C: High density lipoprotein cholesterol.

HDL-C: Low density lipoprotein cholesterol.

Blood Parameters of Experimental Group Quail Chicks: The results of the estimated blood plasma parameters at 49 days old as affected by dietary Moringa dry leaves (MDL) are presented in Table [6].

Except for Values of Albumin and Albumin: globulin ratio, the other parameters of blood plasma determined were not affected (P>0.05) by incorporation MDL at different levels in Japanese quail chicks. Values of (total protein, globulin, high density lipoprotein-cholesterol and GPT) were insignificantly (P<0.05) increased with adding MDL in quail chicks diets, meanwhile, values of (triglycerides, total cholesterol, high density lipoprotein--cholesterol and creatinine) were insignificantly (P<0.05) decreased. Absence of significant differences among treatment diets in plasma GPT in our work may reflect normal liver function of the chicks fed diets containing MDL.

These results in harmony with those noted by EL-Moustafa *et al.* [5] who found that feeding quail chick's diets contained 0.02, 0.40 and 0.60% Moringa oleifera leaf meal (MOLM) increased high density lipoprotein-cholesterol (HDL-C) and decreased low density lipoprotein-cholesterol (LDL-C) concentration in all treatments comparing with control group. These results could be evidence of the effect of MDL on plasma cholesterol reduction especially LDL. The best level of MDL was 0.40 % which recorded decrease in plasma cholesterol, meanwhile, blood plasma of chicks fed 0.20% MDL containing diet recorded the lowest value of LDL and createnine, however it recorded the highest value of plasma HDL compared to the others groups. In another study made by Dey and De [44] observed that inclusion 0.25 or 0.40 % MOLM in broiler diets significantly ($P<0.01$) reduced total cholesterol, triglyceride, LDL-cholesterol and increase in HDL-cholesterol in MOL supplemented birds. The present results cleared that total protein was insignificantly (($P<0.05$) increased with incorporation MDL in the diets comparing with the control group. Total plasma protein has been reported as an indication of the protein retained in the animal body [49]. Meantime, ALT, albumin, total protein, globulin and the albumin/ globulin ratio (A/G) were not affected due to any dietary treatment that done by Elwy *et al.* [16].

The relatively greater total plasma protein content of broilers receiving dietary MOLM might be an indication of the good protein content and/or quality of the leaf meal. Also, the absence of significant deference's indicate normal liver function of the birds on diets containing MSL [16]. Incorporation 0.20% MDL in the diet increased levels of plasma globulin led to significant decreased significantly in plasma albumin compared with control group. Generally, total protein and globulin were increased with adding MDL compared to control group. While, A/G ratio in all dietary treatments appeared to be decreased and this means that immunity of birds fed different MDL as feed additive was improved compared to the control group. This result is also supported by study carried out by Olugbemi *et al*. [50] who noted that Moringa oleifera leaves had a beneficial effect on the immune responses and improve intestinal health of broilers. Also, Makanjuola *et al.* [46] found that adding MOLM at 0.20, 0.40 and 0.60% did not influence the serum total protein, albumin, globulin and AST. But ALT significant decrease was observed in the birds on diet (0.40 %). Thus, the efficient nutrient utilization noted in our study in MDL supplemented chicks may suggest tissue bio-efficiency of polyphenols or their metabolites present in moringa leaves as noted by Brenes *et al.* [51]. In our study, dietary supplementary levels of MOL appeared safe, as they did not adversely affect birds' physiology as mentioned by Lu *et al*. [52].

Carcass Parameters and Dressing Percentages of the Experimental Groups: Data of Table [7] showed that blood, feather head, liver, gizzard, testes weights were not affected by adding moringa dry leaves ((MDL) at different levels. Meanwhile, incorporation MDL at 0.20% ((D_2) significantly increased digestive tract (weight or % of SW), legs (weight or % of SW), total non edible offals (weight or % of SW), liver (% of SW), heart (weight or % of SW) and total edible offals (giblets) that expressed as (weight or % of SW).

Values of both hot carcass weight (CW_1) and hot carcass weight plus giblets (CW_2) were not significantly ($P>0.05$) affected by incorporation MDL in the diets. Also, dressing percentages (DP) expressed as CW_1 / SW (DP_1) or CW_2/ SW (DP_2) significantly ($P<0.05$) decreased by inclusion MDL at 0.20% compared to control diet (D_1), however the others MDL supplementation 0.0.40, 0.60 and 0.80% (D_3, D_4 and D_5) were not significantly ($P>0.05$) affected when compared with the control ((D_1) or 0.20% MDL (D_2).

As cleared in Table [8] dietary treatments had no significant effect ($P>0.05$) on carcass cuts of different experimental groups. These results in the present study in agreement with those reported by EL-Moustafa *et al.* [5] who noted that dietary supplementation of MOLM at 0.0, 20, 0.40 and 0.60% did not significantly affected the relative weights of dressing, breast, thigh, liver, heart, giblets and total edible parts.

Also, Ologhobo *et al.* [53] reported that, feeding MOLM at 0.2, 0.4 and 0.6% levels had no negative influence on the carcass quality but rather improved the breast and drumstick of broiler chicks. On the other hand, David *et al.* [19] found that adding 0.1% Moringa leaf powder (MLP) or 0.1% Moringa fruit powder (MFP), had significantly ($P<0.05$) improved dressing percentage compared to the negative control. Also, they observed that the dietary herbal supplement of 0.1% of MFP increased the gizzard fat content while, 0.1% of MLP reduced the gizzard fat. Also, Karthivashan *et al.* [48] found that broiler feed supplemented with 0, 0.5, 1.0 and 1.5% of MOLM extracts, had significantly ($P<0.05$) higher dressing percentage and meat :fat compared to broilers fed control, while 1.0% MOLM showed the highest dressing percentage and meat: fat.

Table 7: Carcass parameters and dressing percentages of the experimental groups

Item		Experimental diets (g MDL/ kg diet) D_1 0 MDL	D_2 2 g MDL	D_3 4 g MDL	D_4 6 g MDL	D_5 8 g MDL	SEM
Slaughter weight (SW), g		256	260	260	265	268	3.15
Non edible offals:							
Blood	Weight, g	14.00	15.00	15.00	15.00	15.00	0.41
	% of SW	5.47	5.77	5.77	5.66	5.60	0.12
Feather	Weight, g	14.00	16.00	14.00	15.00	16.00	0.40
	% of SW	5.47	6.15	5.38	5.66	5.97	0.13
Digestive tract	Weight, g	11.00^{c}	13.00^{ab}	12.00^{bc}	14.00^{a}	14.00^{a}	0.33
	% of SW	4.30^{b}	5.00^{ab}	4.62^{ab}	5.28^{a}	5.22^{a}	0.13
Legs	Weight, g	5.00^{b}	6.00^{a}	5.00^{b}	5.00^{b}	5.00^{b}	0.13
	% of SW	1.95^{b}	2.31^{a}	1.92^{b}	1.89^{b}	1.87^{b}	0.05
Head	Weight, g	10.00	11.00	11.00	10.00	10.00	0.20
	% of SW	3.90	4.23	4.23	3.77	3.73	0.90
Total	Weight, g	54.00^{b}	61.00^{a}	57.00^{ab}	59.00^{ab}	60.00^{ab}	0.92
	% of SW	21.09^{b}	23.46^{a}	21.92^{ab}	22.26^{ab}	22.39^{ab}	0.28
Edible offals (giblets):							
Liver	Weight, g	6.00	8.00	6.00	7.00	6.00	0.31
	% of SW	2.34^{b}	3.08^{a}	2.31^{b}	2.64^{ab}	2.24^{b}	0.11
Gizzard	Weight, g	5.00	6.00	6.00	6.00	5.00	0.18
	% of SW	1.95	2.31	2.31	2.26	1.87	0.07
Heart	Weight, g	2.00^{b}	3.00^{a}	3.00^{a}	2.00^{b}	2.00^{b}	0.13
	% of SW	0.79^{b}	1.15^{a}	1.15^{a}	0.76^{b}	0.75^{b}	0.05
Testes	Weight, g	6.00	6.00	6.00	7.00	7.00	0.30
	% of SW	2.34	2.31	2.31	2.64	2.60	0.12
Total	Weight, g	19.00^{b}	23.00^{a}	21.00^{ab}	22.00^{ab}	20.00^{ab}	0.54
	% of SW	7.42^{b}	8.85^{a}	8.08^{ab}	8.30^{ab}	7.46^{ab}	0.21
Carcass weight:							
Hot carcass weight (CW_1), g		183	176	182	184	188	2.71
Hot carcass weight plus total edible offals (giblets), g (CW_2)		202	199	203	206	208	2.69
Dressing percentages (DP) expressed as:							
$DP_1 = CW_1 / SW$		71.48^{a}	67.69^{b}	70.00^{ab}	69.43^{ab}	70.15^{ab}	0.40
$DP_2 = CW_2 / SW$		78.91^{a}	76.54^{b}	78.08^{ab}	77.74^{ab}	77.61^{ab}	0.28

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.

Table 8: Carcass cuts of the experimental groups

Item		Experimental diets (g MDL/ kg diet) D_1 0 MDL	D_2 2 g MDL	D_3 4 g MDL	D_4 6 g MDL	D_5 8 g MDL	SEM
Weight of half quail (WHQ), g		92	88	91	92	94	1.33
Fore quarter:							
Neck	Weight, g	5.00^{b}	5.00^{b}	5.00^{b}	5.00^{b}	6.00^{a}	0.12
	% of WHQ	5.43^{b}	5.68^{ab}	5.49^{b}	5.43^{b}	6.38^{a}	0.13
Wing	Weight, g	3.00	3.00	3.00	3.00	3.00	0.00
	% of WHQ	3.26	3.41	3.30	3.26	3.19	0.04
Breast	Weight, g	50.00	49.00	51.00	51.00	52.00	0.83
	% of WHQ	54.35	55.68	56.04	55.43	55.32	0.43
Total	Weight, g	58.00	57.00	59.00	59.00	61.00	0.84
	% of WHQ	63.04	64.77	64.84	64.13	64.89	0.41
Hind quarter:							
Dram stick	Weight, g	10.00	9.00	10.00	10.00	10.00	0.26
	% of WHQ	10.87	10.23	10.99	10.87	10.64	0.20
Thigh	Weight, g	24.00	22.00	22.00	23.00	23.00	0.47
	% of WHQ	26.09	25.00	24.18	25.00	24.47	0.28
Total	Weight, g	34.00	31.00	32.00	33.00	33.00	0.69
	% of WHQ	36.96	35.23	35.16	35.87	35.11	0.41

a and b: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.

CONCLUSION

Under the same conditions for our study, it can be mentioned that addition Moringa dry leaves in Japanese quail chicks improved their productive performance and not realized any adverse effect on carcass characteristics or blood constituents.

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