ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

OPEN ACCESS International Journal of Poultry Science

ISSN 1682-8356
DOI: 10.3923/ijps.2018.536.542

Research Article
Effect of Dietary Supplementation with Differing Levels of *Moringa oleifera* Leaf Meal on the Productivity and Carcass Characteristics of Broiler Chickens

[1]Aqeel Yousif Alshukri, [2]Nihad Abdul-Lateef Ali, [3]Rabia J. Abbas, [4]Ali M. Alkassar and [5]Yasser J. Jameel

[1]Department of Animal Production, College of Agriculture, University of AL-Kufa, Najaf, Iraq
[2]Department of Animal Production, College of Agriculture, University of AL-Qasim Green, Babylon, Iraq
[3]Department of Animal Production, College of Agriculture, University of Basra, Basra, Iraq
[4]College of Veterinary Medicine, University of AL-Kufa, Najaf, Iraq
[5]College of Veterinary Medicine, University of Kerbala, Karbala, Iraq

Abstract

Background and Objective: The search for safe and natural alternatives to reduce over-dependence on the use of antibiotics as growth promoters has led to the evaluation of the effects of natural feed additives, such as plants (phytobiotic), to use in animal nutrition. *Moringa oleifera* leaf meal is a valuable alternative to promote growth and carcass yield in poultry. The aim of this study was to evaluate the effect of *Moringa oleifera* leaf as feed additive in terms of growth performance, feed consumption and carcass characteristics of broiler chickens. **Methodology:** The present study used a completely randomized design (CRD) with five dietary treatment groups (0, 0.25, 0.50, 0.75 and 1.0% *Moringa oleifera* leaf meal) and three replicates per treatment (15 birds/pen). A total of 225 day-old broiler chicks (Ross 308) were included in the experiment for a 42-day period. The measured traits were body weight, body weight gain, feed intake, feed conversion ratio, carcass weight, dressing percentage, total edible parts and European production efficiency factor (EPEF indexes). **Results:** Significant improvements ($p \leq 0.05$) in final body weight, total body weight gain, feed conversion ratio, growth ratio, carcass weight, dressing percentage, total edible parts and EPEF indexes were noted, whereas feed intake was not significantly altered by *Moringa oleifera* leaf meal treatments compared with the control. **Conclusion:** A diet supplemented with *Moringa oleifera* leaf meal was the best natural feed additive for production enhancement and better carcass quality in broiler chicks.

Key words: Broilers, *Moringa oleifera*, growth performance, carcass quality

Citation: Aqeel Yousif Alshukri, Nihad Abdul-Lateef Ali, Rabia J. Abbas, Ali M. Alkassar, Yasser J. Jameel, 2018. Effect of dietary supplementation with differing levels of *Moringa oleifera* leaf meal on the productivity and carcass characteristics of broiler chickens. Int. J. Poult. Sci., 17: 536-542.

Corresponding Author: Nihad Abdul-Lateef Ali, Department of Animal Production, College of Agriculture, University of AL-Qasim Green, Babylon, Iraq

Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Researchers have great interest in identifying natural growth promoters to enhance poultry production and reduce feed cost. Plant products have been used for centuries by humans as food and to treat ailments. Natural medicinal products originating from herbs and spices have also been used as feed additives for farm animals[1]. Animal scientists and veterinarians are now turning their attention to safe and natural additives, such as plants (phytobiotic), to use in animal nutrition. Plants contain phytonutrients and phytochemicals (such as saponins, tannins, oxalates, phytates, trypsin inhibitors and cyanogenic glycosides), which are referred to as secondary metabolites[2]. Plant secondary metabolites are applied for nutrition and as pharmacologically active agents[3]. Moringa (*Moringa oleifera* Lam. moringaceae) is a highly valued plant that is mostly cultivated in the tropics and subtropics. Moringa is used for food, medication and industrial purposes. Its leaves are rich in nutrients and have potential to be used as a feed additive with multiple purposes[4]. *Moringa oleifera* is one of the plants that can be utilized in the preparation of poultry feeds. Plant leaves act as a good source of vitamins, amino acids and natural antioxidant due to the presence of various antioxidant compounds, such as ascorbic acid, flavonoids, phenolics and carotenoids[5,6]. Regarding chemical composition, Oduro *et al.*[7] reported that *Moringa oleifera* leaves contained crude protein: 27.51%, crude fiber 19.25%, crude fiber 2.23%, ash 7.13%, moisture 76.53%, carbohydrates 43.88% and calories 1296 ($kJ\ g^{-1}$). The calcium and iron levels were 20.09 and 28.29 mg/100 g (DM), respectively. Additionally, *Moringa oleifera* leaves have high protein content (20-35% of DM) with high levels of all the essential amino acids[8]. The plant leaves exhibit numerous important medicinal properties, including antioxidant, hepatoprotective, antibacterial and antifungal activities[9] as well as antihepatotoxic and hypoglyceridemic features[10]. Several studies have reported the effects of *Moringa oleifera* leaf meal in poultry diets. The effects of *Moringa oleifera* leaf meal on the growth performance, carcass and organ characteristics, intestinal structure and economics of broiler chickens were studied by Onunkwo and George[11], Laxman[1], Tijani *et al.*[12], Kavoi *et al.*[13] and Agashe *et al.*[14]. These features were studied in laying hens by Abou-Elezz *et al.*[15], Gakuya *et al.*[16] and Elkloub *et al.*[17] studied these features in quail.

A study by Donkor *et al.*[18] indicated that supplementation of *Moringa oleifera* leaves to poultry feed increased the production performance in poultry. Supplementation of *Moringa oleifera* leaf powder also helped in improving immunocompetence and gut health of broilers. Therefore, the aim of the study was to assess the benefits of *Moringa oleifera* leaf as a feed additive in broiler chickens in terms of growth performance, feed consumption and carcass characteristics.

MATERIALS AND METHODS

Experimental birds and treatments: This study was performed at the Poultry Research Farm of the Animal Production Department, College of Agriculture, University of AL-Kufa between 9 October and 19 November 2017. A total of 225 day-old broiler chicks (Ross 308) were randomly distributed among five groups with three replicates (15 birds/pen). Each group was fed one of the following experimental diets. Group 1 was fed the control diet (without supplementation). Groups 2, 3, 4 and 5 were supplied with *Moringa oleifera* leaf meal at 0.25, 0.50, 0.75 and 1.0%, respectively. Basal diets were formulated to meet the nutrient requirements of the broiler (commercial recommendation). The formulation of the basal diet is presented in Table 1. The birds were fed a starter diet until 21days of age followed by a finisher diet from 22-42 days. All birds had *ad libitum* access to feed during the 42-day period. Live body weight was determined through the period from starter to finisher. Feed consumption was recorded for the corresponding periods and the feed efficiency ratio was calculated. The production efficiency factor (PEF), which is also referred to as the European production efficiency factor (EPEF), was calculated according the following equation[20]:

$$\text{EPEF} = \frac{\text{Livability} \times \text{live weight in kg}}{\text{Age in days} \times \text{FCR}} \times 100$$

Carcass characteristics: At the end of the 6th week of the experiment, three birds from each treatment were used to study slaughter traits. The birds were weighed and then slaughtered. The following traits were recorded: Gizzard, liver, heart and total giblets. Then, the percentage of live body weight (BW) was calculated. The relative weights of carcass parts (thigh, breast, back, wings and neck) were calculated as a percentage of dressed weight.

Statistical analysis: Collected data were subjected to analysis of variance using one way ANOVA in accordance with a completely randomized design (CRD) using SPSS software[21]. Significant treatment means were detected by using Least Significant Difference (L.S.D.) test at $p \leq 0.05$[21].

Table 1: Ingredients and nutrient composition of broiler starter and finisher diets

Ingredient (%)	Starter diet (1-21 days)	Finisher diet (22-42 days)
Yellow corn	44.90	49.72
Wheat	10.00	10.00
Soybean meal (47%)	38.00	31.70
Corn oil	2.70	4.50
[1]Premix (20%)	2.50	2.50
Dicalicum phosphate	1.20	1.20
L-lysine	0.10	0.00
DL-methionine	0.30	0.08
Sodium chloride	0.30	0.30
Total	100.00	100.00
Calculated composition[2]		
Metabolizable energy (kcal kg^{-1})	3003.00	3178.00
Crude protein (%)	23.82	20.94
Calorie:protein ratio	126.07	151.77
Calcium (%)	1.00	1.00
Phosphorus available (%)	0.64	0.53
Lysine (%)	1.43	1.23
Methionine+cysteine (%)	1.07	0.86

[1]Premix (BIRMIX M-25)/kg diet: Vitamin A: 400.000 IU, Vitamin D3: 160.000 IU, Vitamin E: 1600 IU, Vitamin K: 80 mg, Vitamin B_1: 80 mg, Vitamin B_2: 240 mg, Calcium pantothenate (CAL-PA): 5200 mg, Niacin: 1400 mg, Vitamin B_6: 1200 mg, Biotin: 2 mg, Folic acid: 40 mg, Vitamin B_{12}: 0.4 mg, Dicalicum phosphate: 120.000 mg, Phytase: 4,000 mg, Premix content with enzyme (%): Protein: 20%, ME: 3000 kcal kg^{-1}, Lysine digested: 5.71, Methionine digested: 8.2 and Common salt: 5.92. [2]Calculated according to the chemical composition of feed stuff contained in NRC[19]

RESULTS AND DISCUSSION

Live body weight and body weight gain: As demonstrated in Table 2, broilers fed on a diet supplemented with *Moringa oleifera* leaf meal exhibited significant ($p \leq 0.05$) increases in final body weight and total body weight gain (BWG) compared with the control group. Body weight gain within the feeding period increased 56.75, 60.03, 60.7, 61.81 and 62.50-fold in chicks that received diets with 0.25, 0.50, 0.75 and 1.0% *Moringa oleifera* leaf meal, respectively. The feed consumption was comparable ($p \geq 0.05$) among the treated groups, which ultimately reduced the feed conversion ratio (FCR) significantly ($p \leq 0.05$) in birds fed diet supplemented with *Moringa oleifera* leaf meal. The present findings are in accordance with Hassan *et al*.[22] who reported that addition of *Moringa oleifera* leaf meal at levels up to 0.3% in broiler diets improved growth performance of broiler chickens reared under heat stress conditions. These findings were also consistent with Agashe *et al*.[14] who concluded that supplementation of *M. oleifera* powder in broiler diets at 2-4 g kg^{-1} of feed improved growth performance. In this respect, Helal, *et al*.[23] revealed that 1% moringa dry leaves or a 0.5+0.5% mixture of moringa leaves and rosemary leaves significantly ($p \leq 0.05$) improved growth performance, nutrient digestibility and antioxidant status of rabbits reared under heat stress conditions. Similar reports are also available in the literature. El-Tazi [24], Dey and De[25] and Elkloub *et al*.[17] observed significant increase in body weights of broiler birds fed diet supplemented with different levels (0.2, 0.4 or 0.6%) of *M. oleifera* leaf meal. Similarly, Teteh *et al*.[26] reported that overall chick weights and daily body weight gain improved significantly with age when 1 and 2% *Moringa oleifera* leaf meal was used in broiler diets. Comparable findings were observed by Karthivashan *et al*.[27] in broiler chickens. On the other hand, in rabbits, body weights did not change significantly with the inclusion of 2.5 g *M. oleifera* fresh leaves/kg of body weight, which was added to the feed daily at 21 days of age[28]. Some studies reported that growth performance of broiler was not affected by the diet supplemented with *Moringa oleifera* leaves[29,30]. The increase in body weight and weight gain of chicks might be due to the fact that Moringa leaves are rich in protein, amino acids, vitamins and minerals[6,31] with antimicrobial activity[32] and medicinal properties[33,34]. According to Laxman[1], supplementation with *Moringa oleifera* leaf powder improved immunocompetence and the gut health of broilers. Additionally, the watery and alcoholic *Moringa oleifera* leaf extract acts as an antibacterial agent, growth promoter and antioxidant and offers benefits for immunity and hemato-biochemical parameters in broiler chicks[35]. However, 2.0% *Moringa oleifera* seed powder supplementation reduced weight gain and live weights of the broilers during a starter period[36]. The authors suggested that the reduced growth rate and live weights of the chickens may be due to the presence of phytate, which acts as an anti-nutritional factor.

Cumulative feed consumption and cumulative feed conversion ratio: Cumulative feed intake (FI) results (Table 2) reveal no significant differences between the birds fed diet supplemented with *Moringa oleifera* leaf meal and the non-supplemented group, which is consistent with the results of Ayssiwede *et al*.[37], Paguia *et al*.[29] and Karthivashan *et al*.[27] who reported that FI was not affected by the diet supplemented with *Moringa oleifera* leaf meal. In contrast to the present study, Elkloub *et al*.[17] and Laxman[1] reported that *Moringa oleifera* leaf meal-supplemented diets significantly reduced the feed consumption of broilers fed 0.2, 0.4 and 0.6% of *Moringa oleifera* leaf meal. Alabi *et al*.[38] demonstrated that aqueous extracts of *Moringa oleifera* leaf can be included at levels up to 90 mL L^{-1} in the drinking water of broiler chicken for reduced feed intake (12.83 %) and improved feed conversion efficiency (9.11). Makanjuola *et al*.[39] observed that

Table 2: Effect of the dietary levels of *Moringa oleifera* leaf meal on the overall (1-6 weeks) performance of broiler chickens

	Moringa oleifera leaf meal (%)						
Parameters	0.0	0.25	0.50	0.75	1.0	SEM	p-value
Initial live weight (g)	148.33	148.67	150.00	154.67	150.67	1.19	0.513
Final body weight (g)	2497.00^{b}	2641.00^{a}	2671.00^{a}	2720.00^{a}	2750.00^{a}	27.19	0.005
Body weight gain(g)	2349.00^{b}	2492.00^{a}	2521.00^{a}	2565.00^{a}	2599.00^{a}	26.82	0.006
Growth ratio[1]	56.75^{b}	60.03^{a}	60.71^{a}	61.81^{a}	62.50^{a}	0.62	0.005
Feed intake (g bird^{-1})	4284.00	4156.00	4256.00	4081.00	4300.00	43.32	0.496
Feed efficiency (g:g)	1.82^{b}	1.67^{a}	1.69^{a}	1.59^{a}	1.65^{a}	0.02	0.016
EPEF[2]	326.27^{b}	377.76^{a}	377.77^{a}	406.77^{a}	395.73^{a}	8.50	0.004
Mortality	0.00	0.00	0.00	0.00	0.00	-	-

^{a,b}Means in the same row with no common superscript are significantly different ($p \leq 0.05$). [1]Growth ratio: Mean weight at day 42/mean weight at day 0 (44 g), EPEF[2]: European production efficiency factor index

Moringa oleifera leaf meal supplemented groups (control, 0.2 and 0.6%) exhibited increased feed intake compared with birds fed 0.4%. The results herein revealed that supplementation with *Moringa oleifera* leaf meal enhanced the feed conversion ratio (FCR) of broilers (Table 2). The best cumulative FCR was obtained by using 0.75% *Moringa oleifera* leaf meal compared with control and other treatments. Improved FCR may be attributed to the fact that birds fed *Moringa oleifera* leaf meal-based diets adequately utilized the nutrients they consumed[1]. In addition, better feed conversion ratios in birds fed *Moringa oleifera* leaf meal diets might be due to antimicrobial activity[32] and immune-stimulant activities[35]. This result was similar to the results of Elkloub *et al.*[17] and Agashe, *et al.*[14] who recorded best feed conversion ratios in birds fed 0.2% *Moringa oleifera* leaf meal. Banjo[19] reported that different levels of *Moringa oleifera* leaf meal (0, 1, 2 and 3%) significantly improved FCR compared with the control group, whereas the diets produced no significant ($p \leq 0.05$) impact on the protein efficiency ratio of broiler birds. In addition, Karthivashan *et al.*[27] observed that using 0, 0.5, 1.0 and 1.5% of *Moringa oleifera* leaf meal extracts yielded significantly better FCR compared with the control. Hossam *et al.*[35] also reported significantly improved feed conversion ratios in the *Moringa oleifera* leaf extract-supplemented groups. Other scientists reported that the feed conversion ratio was not influenced by the diet supplemented with *Moringa oleifera* leaf[26,39,29]. No chicken deaths were observed throughout the experimental period. In this respect, Karthivashan *et al.*[27] reported that approximately 2% mortality was observed for all groups and no significant differences in all treatment groups were noted when broilers were fed diets containing different levels of moringa leaf meal. The European Performance Efficiency Factor index (EPEF) is presented in Table 2. Moringa oleifera leaf meal supplementation significantly ($p \leq 0.05$) improved EPEF values. The highest value was recorded in 4th group (406.77) followed by the 5th group (395.73), 3rd group (377.77) and 2nd group (377.76), whereas the control diets exhibited the lowest values (326.27) on day 42 at the end of the experiment. The better feed conversion ratio and the absence of mortality positively reflected the improved EPEF index. These results are consistent with those of Mousa *et al.*[40] who demonstrated that broiler chicks fed diets supplemented with *Moringa oleifera* leaf meal significantly exhibited the highest EPEI value compared with the control group.

Carcass characteristics: The effect of *Moringa oleifera* leaf meal supplementation on carcass characteristics of broiler chickens at 42 days of age are presented in Table 3. Significant differences ($p \leq 0.05$) in carcass weights, dressing yield (%) and total edible parts (%) were noted. Birds fed diets supplemented with 1% *Moringa oleifera* leaf meal significantly exhibited ($p \leq 0.05$) the greatest carcass weights and the greatest dressing yield with increased total edible parts compared with the control and other treatment groups. These results are consistent with the increasing growth rates, which resulted in increased slaughter weight. On other hand, the dietary supplementation of *Moringa oleifera* leaf meal did not significantly affect the relative weights of breast, thighs, back, wing, neck, giblets, liver, heart and gizzard. With respect to carcass weights and dressing percentage, the results are consistent with those of El-Tazi[24] who reported increased mean values of hot and cold eviscerated carcass weight, dressing percentage and tenderness and juiciness scores of both breast and thigh meat in birds fed *Moringa oleifera* leaf meal-supplemented diets compared with those of the control.

In addition, Karthivashan *et al.*[27] reported that broiler feeds supplemented with 0, 0.5, 1.0 and 1.5% of *Moringa oleifera* leaf meal extracts yielded significantly increased

Table 3: Carcass characteristic at 42 days of age of broilers that received *Moringa oleifera* leaf meal diets

	Moringa oleifera leaf meal (%)						
	0.0	0.25	0.50	0.75	1.0	SEM	p-value
Carcass weight (g)	1735.30^{d}	1751.27^{cd}	1874.70^{bc}	1916.50^{b}	2069.43^{a}	36.119	0.001
Carcass yield (%)	69.53^{b}	66.33^{b}	70.22^{ab}	70.46^{ab}	75.26^{a}	1.014	0.057
Breast yield (%)	36.80	36.70	37.07	37.03	36.90	0.199	0.984
Thigh yield (%)	32.13	32.23	32.60	32.40	32.60	0.304	0.989
Back yield (%)	16.30	16.89	16.35	16.71	16.67	0.151	0.762
Wing yield (%)	9.50	9.33	9.30	9.27	9.27	0.041	0.375
Neck yield (%)	4.87	4.47	4.60	4.57	4.53	0.093	0.770
*Total giblets (%)	4.39	4.26	4.34	4.29	4.40	0.079	0.986
**Total edible parts (%)	73.91^{b}	70.60^{b}	74.56^{ab}	74.75^{ab}	79.66^{a}	1.008	0.045
Liver yield (%)	2.33	2.37	2.37	2.47	2.43	0.049	0.938
Heart yield (%)	0.59	0.50	0.51	0.52	0.51	0.018	0.580
Gizzard yield (%)	1.47	1.40	1.47	1.30	1.47	0.058	0.903

^{a,b}Means on the same row with different superscripts differ significantly ($p \leq 0.05$) SEM: Standard error of means. *Total giblets: (gizzard+liver+heart). ** Total edible parts: Dressing+giblets

dressing percentage and meat:fat compared with control broilers feed, whereas 1.0% *Moringa oleifera* leaf meal exhibited the highest dressing percentage and meat:fat among the treatments. In addition, the result of the internal organs (gizzard, heart and liver) and carcass cuts (breast, thigh, back, wing and neck) in this study are consistent with Onunkwo and George[11] who demonstrated that utilization of *Moringa oleifera* leaf meal in broilers diets does not influence the organ proportion of poultry bird. Similar results were reported by Alabi *et al*.[38] who studied the effect of *Moringa oleifera* leaf extracts on Hubbard broiler chicken and did not observe significant differences in the weights of the breast meat, thighs, wings and drumsticks among the treatments. Contrary to the current findings, Ologhobo *et al*.[41] revealed that the addition of *Moringa oleifera* leaf meal to the diets of broiler chickens had no significant effect on the carcass qualities of the birds. According to the author, higher mean values of slaughter weights (breast, drumstick, spleen and heart) were recorded for birds fed diets containing *Moringa oleifera* leaf meal. Helal *et al*.[23] stated that 1% moringa dry leaves or a 0.5+0.5% mixture of moringa leaves and rosemary leaves did not affect slaughter weight, empty body weight, dressing percentage, total edible offal, non-edible offal and trimmings of rabbits reared under heat stress conditions.

CONCLUSION

On the basis of the results obtained, supplementation of broilers diets with *Moringa oleifera* leaf meal at 0.25, 0.50, 0.75 and 1.0% exhibited significant improvements in final body weight, total body weight gain, feed conversion ratio, growth ratio, carcass weight, dressing percentage, total edible parts and EPEF indexes. Therefore, *Moringa oleifera* supplementation may enhance the growth rate and carcass yield.

ACKNOWLEDGMENTS

The authors thank the Department of Animal Production and Poultry Research Farm at the Agriculture College of AL-Kufa University and its personnel for their assistance with this study.

REFERENCES

1. Laxman, A.J., 2016. Effect of supplementation of *Moringa oleifera* leaf powder on performance of broilers. M.Sc. Thesis, University of Maharashtra Animal and Fishery Science, Nagpur, India.
2. Ogbe, A.O. and J.P. Affiku, 2012. Effect of polyherbal aqueous extracts (*Moringa oleifera*, Gum arabic and wild *Ganoderma lucidum*) in comparison with antibiotic on growth performance and haematological parameters of broiler chickens. Res. J. Recent Sci., 1: 10-18.
3. Soetan, K.O. and O.E. Oyewole, 2009. The need for adequate processing to reduce the antinutritional factors in plants used as human foods and animal feeds: A review. Afr. J. Food Sci., 3: 223-232.
4. Moyo, B., P.J. Masika, A. Hugo and V. Muchenje, 2011. Nutritional characterization of Moringa (*Moringa oleifera* Lam.) leaves. Afr. J. Biotechnol., 10: 12925-12933.
5. Sreelatha, S. and P.R. Padma, 2009. Antioxidant activity and total phenolic content of *Moringa oleifera* leaves in two stages of maturity. Plant Foods Hum. Ntur., 64: 303-311.
6. Moyo, B., S. Oyedemi, P.J. Masika and V. Muchenje, 2012. Polyphenolic content and antioxidant properties of *Moringa oleifera* leaf extracts and enzymatic activity of liver from goats supplemented with *Moringa oleifera* leaves/sunflower seed cake. Meat Sci., 91: 441-447.

7. Oduro, I., W.O. Ellis and D. Owusu, 2008. Nutritional potential of two leafy vegetables: *Moringa oleifera* and *Ipomoea batatas* leaves. Sci. Res. Essay, 3: 57-60.
8. Foidl, N. and R. Paul, 2008. *Moringa oleifera*. In: The Encyclopedia of Fruit and Nutrition, Foidl, N. and R. Paul (Eds.). ABI, Oxfordshire, UK., pp: 509-512.
9. Bukar, A., A. Uba and T.I. Oyeyi, 2010. Antimicrobial profile of *Moringa oleifera* (Lam.) extracts against some food born microorganisms. Bayero J. Pure Applied Sci., 3: 43-48.
10. Akpet, S.O., H.A. Ibekwe and H.A. Onyeama, 2015. Effects of *Moringa oleifera* leaf meal inclusions on serum activities of hepatic marker enzymes and lipid profile of Anak 2000 broiler chicks. Merit Res. J. Agric. Sci. Soil Sci., 3: 168-172.
11. Onunkwo, D.N. and O.S. George, 2015. Effects of *Moringa oleifera* leaf meal on the growth performance and carcass characteristics of broiler birds. IOSR J. Agric. Vet. Sci., 8: 63-66.
12. Tijani, L.A., A.M. Akanji, K. Agbalaya and M. Onigemo, 2016. Comparative effects of graded levels of Moringa leaf meal on haematological and serum biochemical profile of broiler chickens. J. Agric. Sci., 11: 137-146.
13. Kavoi, B.M., D.W. Gakuya, P.N. Mbugua and S.G. Kiama, 2016. Effects of dietary *Moringa oleifera* leaf meal supplementation on chicken intestinal structure and growth performance. J. Morphol. Sci., 33: 186-192.
14. Agashe, J.L., S.J. Manwar, K.K. Khose and M.R. Wade, 2017. Effect of supplementation of *Moringa oleifera* leaf powder on growth performance of broilers. J. Poult. Sci. Technol., 5: 28-34.
15. Abou-Elezz, F.M.K., L. Sarmiento-Franco, R. Santos-Ricalde and F. Solorio-Sanchez, 2011. Nutritional effects of dietary inclusion of *Leucaena leucocephala* and *Moringa oleifera* leaf meal on Rhode Island Red hens' performance. Cuban J. Agric. Sci., 45: 163-169.
16. Gakuya, D.W., P.N. Mbugua, S.M. Mwaniki, S.G. Kiama, G.M. Muchemi and A. Njuguna, 2014. Effect of supplementation of *Moringa oleifera* (Lam) leaf meal in layer chicken feed. Int. J. Poult. Sci., 13: 379-384.
17. Elkloub, K., M.E.L. Moustafa, F.H. Riry, M.A.M. Mousa and A.H. Hanan, 2015. Effect of using *Moringa oleifera* leaf meal on performance of Japanese quail. Egypt. Poult. Sci. J., 35: 1095-1108.
18. Donkor, A.M., R.L.K. Glover, D. Addae and K.A. Kubi, 2013. Estimating the nutritional value of the leaves of *Moringa oleifera* on poultry. Food Nutr. Sci., 4: 1077-1083.
19. Banjo, O.S., 2012. Growth and performance as affected by inclusion of *Moringa oleifera* leaf meal in broiler chicks diet. J. Biol. Agric. Healthcare, 2: 35-38.
20. Aviagen, 2009. Ross broiler management manual. Aviagen, UK., pp: 1-114. http://www.thepoultrysite.com/downloads/download/94/
21. SPSS., 2012. SPSS User's Guide Statistics. Version 19. SPSS Inc., USA.
22. Hassan, H.M.A., M.M. El-Moniary, Y. Hamouda, E.F. El-Daly, A.W. Youssef and N.A. Abd El-Azeem, 2016. Effect of different levels of *Moringa oleifera* leaves meal on productive performance, carcass characteristics and some blood parameters of broiler chicks reared under heat stress conditions. Asian J. Anim. Vet. Adv., 11: 60-66.
23. Helal, F., A. El-Badawi, I. El-Wardany, N. Ali and O. Aboelazab, 2018. Effect of dietary moringa (*Moringa oleifera*) and rosemary (*Rosmarinus officinalis*) leaves or their mixture on productive performance, carcass characteristics and antioxidant enzymes of rabbits reared under heat stress conditions. Agric. Eng. Int.: CIGR J., 19: 184-192.
24. El Tazi, S.M.A., 2014. Effect of feeding different levels of *Moringa oleifera* leaf meal on the performance and carcass quality of broiler chicks. Int. J. Sci. Res., 3: 147-151.
25. Dey, A. and P.S. De, 2013. Influence of *Moringa oleifera* leaves as a functional feed additive on the growth performance, carcass characteristics and serum lipid profile of broiler chicken. Indian J. Anim. Res., 47: 449-452.
26. Teteh, A., E. Lawson, K. Tona, E. Decuypere and M. Gbeassor, 2013. *Moringa oleifera* leave: Hydro-alcoholic extract and effects on growth performance of broilers. Int. J. Poult. Sci., 12: 401-405.
27. Karthivashan, G., P. Arulselvan, A.R. Alimon, I.S. Ismail and S. Fakurazi, 2015. Competing role of bioactive constituents in *Moringa oleifera* extract and conventional nutrition feed on the performance of cobb 500 broilers. BioMed. Res. Int. 10.1155/2015/970398.
28. Osman, H.M., M.E. Shayoub and E.M. Babiker, 2000. The effect of *Moringa oleifera* leaves on blood parameters and body weights of albino rats and rabbits. Jordan J. Biol. Sci., 5: 147-150.
29. Paguia, H.M., R.Q. Paguia, R.C. Flores and C.M. Balba, 2014. Utilization and evaluation of *Moringa oleifera* as poultry feeds. Monograph No. 11. The Research and Development Office, Bataan Peninsula State University City of Balanga, Philippines.
30. Adejola, Y.A., R.A. Sobayo, S.B. Muhammed, D.D. Akinbola and A. Olanrewaju, 2016. Effects of two herbal feed additives with or without grits on growth performance and nutrient digestibility of broiler chickens. J. Anim. Sci. Adv., 6: 1548-1554.
31. Melesse, A., H. Steingass, J. Boguhn and M. Rodehutscord, 2013. *In vitro* fermentation characteristics and effective utilisable crude protein in leaves and green pods of *Moringa stenopetala* and *Moringa oleifera* cultivated at low and mid-altitudes. J. Anim. Physiol. Anim. Nutr., 97: 537-546.
32. Abd El-Moez, S.I., A.Y. El-Badawy and H.A.A. Omer, 2014. Assessment of antimicrobial effect of moringa: *In vitro* and *in vivo* evaluation. Afr. J. Microbiol. Res., 8: 3630-3638.
33. Olugbemi, T.S., S.K. Mutayoba and F.P. Lekule, 2010. Effect of moringa (*Moringa oleifera*) inclusion in cassava based diets fed to broiler chickens. Int. J. Poult. Sci., 9: 363-367.

34. Adegbite, O.A., B. Omolaso S.A. Seriki and C. Shatima, 2016. Effects of *Moringa oleifera* leaves on hematological indices in humans. Ann. Hematol. Oncol., Vol. 3, No. 8.
35. Allam, H., A.M. Abdelazem, H.S. Farag and A. Hamed, 2016. Some hemato-biochemical, bacteriological and pathological effects of *Moringa oleifera* leaf extract in broiler chickens. Int. J. Basic Applied Sci., 5: 99-104.
36. Ochi, E.B., M.E. Elbushra, M. Fatur, O.I. Abubakr and A. Hafiz, 2015. Effect of moringa (*Moringa oleifera* Lam) seeds on the performance and carcass characteristics of broiler chickens. J. Natl. Sci. Res., 5: 66-73.
37. Ayssiwede, S.B., A. Dieng, H. Bello, C.A.A.M. Chrysostome and M.B. Hane *et al*., 2011. Effects of *Moringa oleifera* (Lam.) leaves meal incorporation in diets on growth performances, carcass characteristics and economics results of growing indigenous Senegal chickens. Pak. J. Nutr., 10: 1132-1145.
38. Alabi, O.J., A.D. Malik, J.W. Ng'ambi, P. Obaje and B.K. Ojo, 2017. Effect of aqueous *Moringa oleifera* (Lam) leaf extracts on growth performance and carcass characteristics of Hubbard broiler chicken. Braz. J. Poult. Sci., 19: 273-280.
39. Makanjola, B.A., O.O. Obi, T.O. Olorungbohunmi, O.A. Morakinyo, M.O. Oladele-Bukola and B.A. Boladuro, 2014. Effect of *Moringa oleifera* leaf meal as a substitute for antibiotics on the performance and blood parameters of broiler chickens. Livest. Res. Rural Dev., Vol. 26, No. 8.
40. Mousa, M.A., A.S. Osman and H.A. Hady, 2017. Performance, immunology and biochemical parameters of *Moringa oleifera* and/or *Cichorium intybus* addition to broiler chicken ration. J. Vet. Med. Anim. Health, 9: 255-263.
41. Ologhobo, A.D., E.I. Akangbe, I.O. Adejumo and O. Adeleye, 2014. Effect of *Moringa oleifera* leaf meal as replacement for oxytetracycline on carcass characteristics of the diets of broiler chickens. Annu. Res. Rev. Biol., 4: 423-431.