RESEARCH ARTICLE

Influence of Fortifying Graded Levels of *Moringa oleifera* Leaf Powder on Growth Performance and Haemato-biochemical Indices of Broiler Chickens

Ajeet K. Verma[1]*, Partha S. Pramanik[1], Manoj K. Verma[2], Sachin Gautam[3], Rajesh Kumar[4], Saurabh[4]

Abstract

The study was conducted to evaluate the influence of *Moringa oleifera* leaf powder (MOLP) on the growth and haemato-biochemical indices of broiler chickens. A total of 250-day-old broiler chicks (Vencobb-430) were randomly distributed into five groups with 5 replicates of 10 birds in each. Different dietary treatments were; basal diet with no supplement (NC- negative control) and a basal diet supplemented with antibiotics (PC-positive control), 1% MOLP (MOLP1), 1.5% MOLP (MOLP1.5), and 2% MOLP (MOLP2). Bodyweight gain (BWG), feed intake (FI), feed conversion ratio (FCR), haemato-biochemical parameters, and economics were assessed in 35 days of the experiment. The results showed that BWG of birds was significantly ($p < 0.05$) higher in all Moringa supplement groups than NC group, but similar to PC group birds. Feed intake and FCR of Moringa supplemented and PC groups were significantly ($p < 0.05$) lower than the NC group, except MOLP2, which showed no difference in FI compared with the NC group. MOLP1.5 group birds recorded the best value of FCR among different groups. The highest profit per broiler was recorded in MOLP1.5 followed by MOLP1 and MOLP2 than NC, similar to the PC group. Hb and PCV values of the MOLP1.5 group were significantly ($p < 0.05$) higher than the NC group but comparable to the PC group. Platelet and WBC count were significantly ($p < 0.05$) lower in Moringa supplemented groups than NC and PC groups. A significant ($p < 0.05$) reduction was observed in blood glucose, SGPT, SGOT, cholesterol, and triglyceride levels of Moringa supplemented groups as compared to broilers of PC and NC groups. From the results, it was concluded that supplementation of 1.5% *Moringa oleifera* leaf powder improved the performance of birds without any detrimental effect on their health.

Keywords: Broilers, Growth performance, Haemato-biochemical profile, Leaf powder supplement, *Moringa oleifera*.

Ind J Vet Sci and Biotech (2021): 10.21887/ijvsbt.17.3.7

Introduction

A very strong demand for animal protein for human beings has expanded, consolidated, and globalized in countries of all income levels. The poultry industry in India is one of the fastest-growing livestock sectors, with a growth rate of 8.51 and 7.52 % in egg and broiler production, respectively (BAHS, 2019). Antibiotic feed additives in food-producing animals have been used to meet the increasing demand for animal protein, including improved feed utilization, promotion in growth, and prevention from pathological micro-organisms. However, usage of antibiotic feed additives as growth promoters leads to harmful effects on consumer's health due to augmentation of microbial resistance and residual effect. Considering microbial resistance builds-up forces to reduce antibiotic feed additives in livestock and poultry production (Cheng *et al.,* 2019). Investigating safe and natural antibiotics alternatives is a tremendous challenge for animal scientists and veterinarians to meet the increased demand for providing wholesome meat at a low cost. Dietary inclusion of herbal plants and their extracts have been used as an alternative to antibiotic growth-promoter in poultry production (Movahhedkhah *et al*., 2019).

[1]Department of Livestock Production Management, College of Veterinary Science & Animal Husbandry, ANDUAT, Ayodhya, UP, India

[2]Department of Animal Genetics and Breeding, College of Veterinary Science & Animal Husbandry, ANDUAT, Ayodhya, UP, India

[3]Department of Animal Nutrition, College of Veterinary Science & Animal Husbandry, ANDUAT, Ayodhya, UP, India

[4]Department of Veterinary Gynaecology & Obstetrics, College of Veterinary Science & Animal Husbandry, ANDUAT, Ayodhya, UP, India

Corresponding Author: Ajeet Kumar Verma, Department of Livestock Production Management, College of Veterinary Science & Animal Husbandry, ANDUAT, Ayodhya, UP, India, e-mail: ajeetverma95@gmail.com

How to cite this article: Verma, A.K., Pramanik, P.S., Verma, M.K., Gautam, S., Kumar, R., & Saurabh. (2021). Influence of Fortifying Graded Levels of *Moringa oleifera* Leaf Powder on Growth Performance and Haemato-biochemical Indices of Broiler Chickens. Ind J Vet Sci and Biotech, 17(3): 31-35.

Source of support: Nil

Conflict of interest: None.

Submitted: 21/01/2021 **Accepted:** 21/05/2021 **Published:** 16/08/2021

Moringa oleifera is a fast-growing, drought-resistant multipurpose plant, commonly called the drumstick or magical tree (Sarwatt *et al.,* 2002). It is advantageous as a feed supplement for animals due to its highly nutritious leaves, a prominent source of vitamin B complex, vitamin C, pro-vitamin A in the form of beta-carotene, vitamin K, manganese, and protein, among other essential nutrients (Leone *et al*., 2015). It has essential medicinal qualities, including antioxidant, hepatoprotective, antibacterial, and antifungal activities (Bukar *et al*., 2010). Niaziridin is an active component obtained from *Moringa oleifera* that can improve the absorption of different vitamins, minerals, and other micro-nutrients in the host's gut (Stohs and Hertman, 2015). Quercetin found in dried Moringa leaves has hypolipidemic, hypotensive, and anti-diabetic properties (Rivera *et al.,* 2008). The supplementation of *Moringa oleifera* leaves in poultry feed has improved performance, immunity, and gut health. Therefore, considering the above facts, the present research was planned to study the influence of fortifying the basal diet with graded levels of *Moringa oleifera* leaf powder on the performance of broilers chickens.

Materials and Methods

For the present research, approval from the "Institutional animal ethical committee (IAEC)" was obtained vide reference number IAEC/CVSc/P-36/2019. A total of 250 one-day-old Vencobb-430 strain chicks in a completely randomized design were divided into five dietary treatment groups with five replicates of 10 chicks in each. Dietary treatments included a basal diet without any additive in the negative control (NC) or that supplemented with antibiotics (Positive control, PC), 1% *Moringa oleifera* leaf powder (MOLP1), 1.5% *Moringa oleifera* leaf powder (MOLP1.5), and 2% *Moringa oleifera* leaf powder (MOLP2). Birds were fed *ad libitum* in pre-starter (1–7 days), starter (8–22 days), and finisher (23–35 days) phases. The experimental diets were formulated as per BIS (2007). The chicks were kept on a deep litter system under uniform standard management conditions and provided fresh, wholesome drinking water.

Individual body weight (BW) at zero-day and weekly intervals were recorded for up to 35 days. Replicate wise feed intake (FI) of chicks was recorded at the weekly interval, and from these data, body weight gain (BWG) and feed conversion ratio (FCR) were calculated. After 35 days of the experiment, the economic return was also estimated to determine the commercial viability of *Moringa oleifera* leaf powder supplementation in broiler production. At the end of the experiment, blood samples were collected aseptically from the wing vein to assess the haemato-biochemical indices. The hematological parameters were estimated by using the Nihon Kohden automated hematology analyzer (MEK-6420P, Celltac α, Nihon Kohden, India). Glucose, total protein, albumin, globulin, total cholesterol, triglyceride, SGOT, and SGPT were estimated from the serum samples using Autospan commercial diagnostic kits (Arkrey Healthcare Private Limited, Surat, India) on a biochemistry analyzer.

The data were analyzed under a completely randomized design by employing a one-way analysis of variance (Snedecor and Cochran, 1994). The means of different dietary treatments were compared by applying Duncan multiple range test (DMRT). The P values less than 0.05 were considered significant.

Results and Discussion

Growth Performance and Economics

The data about the growth performance of birds in terms of BWG, FI, FCR, EBI, EPEF, and economic return are presented in Table 1. The body weight gain (BWG) of *Moringa oleifera* leaf powder and antibiotic supplemented groups were

Table 1: Influence of different dietary levels of Moringa leaf powder on growth performance of broiler chickens

	Dietary Groups					
Attributes	*NC*	*PC*	*MOLP1*	*MOLP1.5*	*MOLP2*	*P-value*
Initial BW (g)	55.63±0.56	55.48±0.49	55.19±0.51	55.94±0.52	55.90±0.53	0.845
Final BW (g)	2066.02±35.26^{a}	2181.88±31.50^{b}	2213.18±30.03^{b}	2217.74±32.69^{b}	2244.52±27.51^{b}	0.001
BW gain/broiler (g)	2007.78±33.68^{a}	2126.38±31.17^{b}	2157.98±29.65^{b}	2161.79±32.26^{b}	2188.62±27.12^{b}	<0.001
Feed intake/broiler (g)	3393.94±20.11^{d}	3301.48±18.38^{bc}	3258.32±19.97^{ab}	3241.83±18.64^{a}	3342.15±18.57^{cd}	<0.001
FCR	1.71±0.023^{c}	1.56±0.015^{b}	1.52±0.013^{ab}	1.51±0.014^{a}	1.53±0.012^{ab}	<0.001
EBI*	321.12±8.69^{a}	385.24±9.40^{b}	409.67±8.88^{bc}	413.73±10.16^{c}	410.69±8.09^{bc}	<0.001
EPEF**	329.97±8.68^{a}	395.25±9.55^{b}	420.11±9.04^{bc}	424.40±10.34^{c}	421.15±8.24^{bc}	<0.001
Total cost/broiler (Rs.)	137.26±0.55^{b}	135.43±0.05^{a}	134.75±0.55^{a}	134.90±0.51^{a}	138.20±0.52^{b}	<0.001
Sale price/broiler (Rs.)	175.39±2.90^{a}	185.46±2.68^{b}	188.12±2.55^{b}	188.51±2.78^{b}	190.78±2.34^{b}	0.001
Profit/broiler (Rs.)	38.13±2.41^{a}	50.03±2.22^{b}	53.37±2.04^{b}	53.61±2.30^{b}	52.58±1.88^{b}	<0.001
Profit index	0.21±0.01^{a}	0.26±0.01^{b}	0.28±0.01^{b}	0.28±0.01^{b}	0.27±0.01^{b}	<0.001

Means with different superscripts in a row between groups differ significantly ($p < 0.05$). * European broiler index; ** European production efficiency factor.

significantly ($p < 0.05$) higher as compared to NC group birds. MOLP2 group showed no difference in feed intake compared with PC and NC groups. However, significantly ($p < 0.05$) lowest feed intake was observed in MOLP1 and MOLP1.5 group birds. Broilers supplemented with 1.5% Moringa leaf powder showed a significantly ($p < 0.05$) lower feed conversion ratio (FCR) as compared to antibiotic and without supplement group. However, the FCR of MOLP1 and MOLP2 group birds showed no difference compared with the PC group. The European broiler index (EBI) and European production efficiency factor (EPEF) of Moringa supplemented groups were significantly ($p < 0.05$) higher than NC group birds but similar to the PC group. Among the Moringa supplements, broilers fed with 1.5 % Moringa had the highest EBI and EPEF. The economic data showed that the cost per broiler in MOLP1 and MOLP1.5 was significantly ($p < 0.05$) lower than NC and similar to PC groups. However, MOLP2 groups showed significantly ($p < 0.05$) higher cost per broiler than the PC group. Profit per bird of Moringa supplemented, and PC groups were significantly ($p < 0.05$) higher than NC group birds. MOLP1.5 group birds recorded the highest profit per bird (Table 1).

The present findings of better BWG in Moringa supplemented group birds agreed with the findings of Edu *et al.* (2019) and Mikhail *et al.* (2020). Similarly, Sarker *et al.* (2017) found higher weight gain in broilers fed Moringa. The lower FCR values in Moringa supplemented groups agreed with the findings of Mousa *et al.* (2017) and Madavi *et al.* (2021). The lower FCR values / higher feed efficiency in Moringa supplemented groups might be due to better feed utilization. The higher profit in Moringa leaf supplemented groups of birds in the present study was following the results of Meshram *et al.* (2019), who observed an increase in economic profit, especially with broiler group received 0.5% Moringa leaf meal (MOLM) followed by 1% and 2% MOLM compared to no supplement group. The improvement in performance indices of the broilers might be due to the presence of a significant quantity of vitamins and minerals and several antioxidant compounds in Moringa leaves.

Hematological Parameters

The results of hematological indices are given in Table 2. The RBC value of MOLP2 was significantly ($p < 0.05$) higher than NC and MOLP1 group. Similarly, the MCH value of MOLP2 was significantly ($p < 0.05$) higher than NC, PC and MOLP1.5 group. Hemoglobin and PCV values of MOLP1.5 and PC groups were significantly ($p < 0.05$) higher than NC group and similar to MOLP2 group birds. There was no difference observed in MCHC level of MOLP2 compared with NC and PC groups; however, MOLP1 showed significantly ($p < 0.05$) lowest MCHC level. Platelet and WBC count of Moringa supplemented groups were significantly ($p < 0.05$) lower than NC and PC group broilers. Moringa supplemented birds had significantly ($p < 0.05$) higher lymphocyte and monocyte than NC and PC group birds. At the same time, granulocyte percent of MOLP1 was significantly ($p < 0.05$) lower in MOLP1, MOLP1.5, and MOLP2 groups than PC and NC group broiler birds.

The present hematological values are within normal range showing no harmful effect of Moringa supplementation on broiler chickens. Increased value of RBCs in the 1.5% Moringa supplement group was in harmony with the results of Abbas *et al.* (2018). Baobab and Moringa leaf meal supplementation also increased the hematological parameters of broilers (Hassan *et al.,* 2017). Contrary to these findings, Aiyedun *et al.* (2020) found no significant effect of Moringa leaf meal supplementation on Hb, PCV, RBC, MCV, and MCH values of broiler birds. Low WBC count and lymphocyte percentage in Moringa supplemented group was similar to the results of Hafsa *et al.* (2020), while Omar *et al.* (2020) observed significantly higher values of white blood cells in Moringa supplemented broiler birds. The low values of RBC, Hb, and PCV in MOLP1 group may be due to the cumulative effect of a

Table 2: Influence of different dietary levels of Moringa leaf powder on haematological parameters of broiler chickens

	Dietary Groups					
Attributes	*NC*	*PC*	*MOLP1*	*MOLP1.5*	*MOLP2*	*P- value*
RBCs (10^3/µL)	2.27 ± 0.039^{ab}	2.61 ± 0.014^{bc}	2.14 ± 0.034^{a}	2.58 ± 0.148^{bc}	2.68 ± 0.208^{c}	0.015
Haemoglobin (g/dl)	11.16 ± 0.35^{ab}	12.83 ± 0.085^{d}	10.22 ± 0.086^{a}	12.36 ± 0.52^{cd}	11.50 ± 0.317^{bc}	<0.001
PCV (%)	29.93 ± 0.61^{a}	34.28 ± 0.11^{b}	28.50 ± 0.41^{a}	34.46 ± 2.04^{b}	31.30 ± 0.98^{ab}	0.002
MCV (fL)	133.20 ± 0.49	131.80 ± 1.15	133.4 ± 0.24	133.00 ± 1.04	133.66 ± 0.66	0.172
MCH (pg)	47.50 ± 0.10^{b}	47.32 ± 0.08^{ab}	47.73 ± 0.35^{bc}	46.76 ± 0.29^{a}	48.32 ± 0.07^{c}	0.001
MCHC (g/dl)	37.23 ± 0.52^{bc}	37.50 ± 0.14^{c}	35.60 ± 0.23^{a}	36.76 ± 0.56^{ab}	36.67 ± 0.17^{abc}	0.020
Platelets (10^3/µL)	57.20 ± 4.4^{c}	51.40 ± 0.50^{c}	31.2 ± 1.77^{b}	20.66 ± 1.93^{a}	15.00 ± 1.58^{a}	<0.001
WBCs (103/µl)	15.40 ± 0.58^{c}	15.88 ± 0.71^{c}	9.10 ± 0.45^{a}	10.76 ± 0.58^{ab}	11.38 ± 0.42^{b}	<0.001
Lymphocyte (%)	50.20 ± 3.32^{a}	49.16 ± 3.31^{a}	55.62 ± 2.53^{b}	56.52 ± 3.31^{b}	53.80 ± 2.75^{ab}	0.002
Granulocyte (%)	47.94 ± 3.04^{b}	48.20 ± 3.58^{b}	41.28 ± 2.56^{a}	40.58 ± 2.92^{a}	43.36 ± 2.76^{a}	0.001
Monocyte (%)	1.78 ± 0.44^{a}	2.02 ± 0.48^{a}	3.08 ± 0.44^{b}	2.85 ± 0.50^{b}	2.83 ± 0.52^{b}	0.011

Means with different superscripts in a row between groups differ significantly ($p < 0.05$).

Table 3: Influence of different dietary levels of Moringa leaf powder on biochemical profile of broiler chickens

	Dietary Groups					
Attributes	*NC*	*PC*	*MOLP1*	*MOLP1.5*	*MOLP2*	*P-value*
SGPT (U/L)	14.13 ± 1.06^{b}	12.25 ± 0.85^{ab}	8.34 ± 1.10^{a}	9.27 ± 1.22^{a}	9.08 ± 0.89^{a}	0.002
SGOT (U/L)	225.75 ± 2.45^{b}	220.97 ± 3.19^{b}	210.81 ± 3.09^{a}	211.17 ± 2.00^{a}	208.35 ± 2.93^{a}	0.002
Total protein (g/dl)	3.10 ± 0.08^{a}	3.17 ± 0.11^{a}	3.83 ± 0.14^{b}	3.50 ± 0.18^{ab}	3.95 ± 0.04^{b}	<0.001
Albumin (g/dl)	1.24 ± 0.04^{a}	1.28 ± 0.03^{a}	1.36 ± 0.14^{ab}	1.28 ± 0.03^{a}	1.38 ± 0.03^{b}	0.001
Globulin (g/dl)	1.86 ± 0.09^{a}	1.89 ± 0.09^{a}	2.47 ± 0.22^{b}	2.22 ± 0.19^{ab}	2.57 ± 0.01^{b}	0.010
A/G ratio	0.67 ± 0.07^{c}	0.68 ± 0.12^{c}	0.55 ± 0.13^{a}	0.58 ± 0.17^{bc}	0.54 ± 0.01^{a}	0.025
Cholesterol (mg/dl)	119.90 ± 5.62^{b}	117.68 ± 6.57^{b}	104.81 ± 3.63^{a}	94.37 ± 3.63^{a}	89.56 ± 4.72^{a}	0.011
Triglyceride (mg/dl)	116.83 ± 4.48^{bc}	122.18 ± 6.33^{c}	103.61 ± 5.46^{ab}	97.52 ± 2.82^{a}	97.01 ± 3.16^{a}	0.002
Blood glucose (mg/dl)	279.86 ± 3.37^{b}	271.82 ± 3.71^{b}	262.93 ± 3.42^{a}	255.14 ± 3.66^{a}	259.64 ± 4.06^{a}	0.001

Means with different superscripts in a row between groups differ significantly ($p < 0.05$).

high level of tannin and saponins in the leaves, but it is also a vibrant source of iron as well as other minerals, vitamins, and protein, so might not affect these values among MOPL1.5 and MOLP2 group birds (Teteh *et al*., 2013). The low WBC count of MOLP1 group might be possible due to the antimicrobial activity of phytochemicals in the Moringa leaves, resulting in altered microflora of birds (Djakalia *et al*., 2011).

Biochemical Parameters

The findings of biochemical parameters are presented in Table 3. The SGOT, SGPT, and blood glucose levels of Moringa leaf supplemented groups were significantly ($p < 0.05$) lower than PC and NC group birds. Total serum protein and globulin concentrations of MOLP1 and MOLP2 were significantly ($p < 0.05$) higher than PC group, and similar to NC group birds; however, MOLP1.5 group showed no difference with PC group. The albumin level of MOLP2 group was statistically similar to MOLP1 but significantly ($p < 0.05$) higher than MOLP1.5, NC, and PC group.. The serum cholesterol and triglyceride levels in Moringa supplemented groups were significantly ($p < 0.05$) lower than NC and PC group broilers; except, the MOLP1 group showed no difference in triglyceride concentration compared with NC group.

The present finding showed that biochemical parameters were in the normal range among all the groups. Like the present outcome, Hafsa *et al.* (2020) reported a significant reduction in SGOT and SGPT values of Moringa-treated birds, whereas Abdel-Azeem *et al.* (2017) recorded insignificant difference in SGPT and SGOT levels of broilers supplemented with Moringa leaf meal. Further, Ashour *et al.* (2020) reported a comparable insignificant effect of MOLM supplementation on serum total protein, albumin, and globulin levels in broiler birds. In contrast to this study, Abbas *et al.* (2018) and Mousa *et al.* (2017) recorded a significant ($p \leq 0.05$) increase in total protein, albumin, and globulin of broilers fed increasing levels of MOLP in the diets. The decrease in cholesterol and triglyceride concentrations of broilers in Moringa leaf supplemented groups compared to antibiotic and without supplement group were in the line of Ajantha *et al.* (2020). AbouSekken (2015) also recorded a significant ($p < 0.05$) decrease in total cholesterol and LDL, but an increase in HDL values among Moringa supplemented group birds.

Conclusion

Based on present findings, it was concluded that fortifying 1.5% Moringa leaf powder improved the growth performance and decreased the serum cholesterol level without any harmful effect on the bird's health. Therefore, using 1.5% Moringa leaf powder as an alternative to an antibiotic feed additive can be recommended as a growth promoter for broiler production.

Acknowledgement

Authors are grateful to Hon'ble Vice-Chancellor, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India, to provide necessary research facilities.

References

Abbas, R.J., Ali, N.A., Alkassar, A.M., & Jameel, Y.J. (2018). Haematological and biochemical indices of broiler chicks fed at different levels of *Moringa oleifera* leaf meal. *Biochemical and Cellular Archives*, *18*(2), 1931-1936.

Abdel-Azeem, A.F., Mohamed, F.A., El-Shiekh, S.E.M., & Hessin, A.F. (2017). Maximizing productivity of Lohmann chickens by feeding diets inclusion different levels of *Moringa oleifera* leaf powder as a safe feed additive. *Journal of Animal and Poultry Production*, *8*(8), 319-328.

AbouSekken, M.S.M. (2015). Performance, immune response and carcass quality of broilersfed low protein diets contained either *Moringa oleifera* leaves meal or its extract. *Journal of American Science*, *11*(6), 153-164.

Ajantha, A., Kathirvelan, C., Purushothaman, M.R., & Visha, P. (2020). Effect of *Moringa oleifera* leaf meal supplementation in broiler chicken on serum and muscle lipid profile. *Journal of Pharmacognosy and Phytochemistry*, Sp *9*(2), 464-466.

Ashour, E.A., El-Kholy, M.S., Alagawany, M., Abd El-Hack, M.E., Mohamed, L.A., Taha, A.E., El Sheikh, A.I., Laudadio, V., &

Tufarelli, V. (2020). Effect of dietary supplementation with *Moringa oleifera* leaves and/or seeds powder on production, egg characteristics, hatchability and blood chemistry of laying Japanese Quails. *Sustainability, 12,* 2463, 1-9.

Aiyedun, J.O., Oladele-Bukola, M.O., Olatoye, I.O., Oludairo O.O., & Ogundipe G.A.T. (2020). Growth, antibacterial properties and haematological parameters of broiler chickens fed Moringa and neem leaf meals as additives. *Nigerian Journal of Animal Science*, *22*(2), 126-139.

BAHS (Basic Animal Husbandry Statistics) (2019). Department of Animal Husbandry, Dairying and Fisheries, Government of India. Accessed Feb. 2020.

BIS (2007). *Poultry Feed Specification*. 5th Review of Bureau of Indian Standards. New Delhi, India.

Bukar, A., Uba, A., & Oyeyi, T.I. (2010). Antimicrobial profile of *Moringa oleifera* extracts against some food borne micro-organisms. *Bayero Journal of Pure and Applied Sciences, 3*(1), 43-48.

Cheng, Y., Chen, Y., Li, J., Qu, H., Zhao, Y., Wen, C., & Zhou, Y. (2019). Dietary β-sitosterol improves growth performance, meat quality, antioxidant status, and mitochondrial biogenesis of breast muscle in broilers. *Animals, 9,* 71.

Djakalia, B., Guichard, B.L. & Soumaila, D. (2011). Effect of *Moringa oleifera* on growth performance and health status of young post-weaning rabbits. *Research Journal of Poultry Sciences*, 4, 7-13.

Edu, N.E., Ekpo, P. B., Umoyen, A. J., Thomas, T. L., Akpan, M.O., Leo, E.A., & Job, I.E.(2019). Evaluating the effect of Moringa (*Moringa oleifera*) leaf supplemented feed on the growth and carcass quality of broilers in Calabar. *Asian Journal of Advanced Research and Reports*, *7*(1), 1-7.

Hafsa S.H.A., Ibrahim S.A., Eid Y.Z., & Hassan A.A. (2020). Effect of dietary *Moringa oleifera* leaves on the performance, ileal microbiota and antioxidative status of broiler chickens. *Journal of Animal Physiology and Animal Nutritio*n, *104*(2), 229-238.

Hassan, A.U., Sakaba, A.M., Harande, I.S., S. M. Isgogo, S.M., Danbare, B.M., Maiyama, F.A. & Bagudo, A.M. (2017). Serum biochemistry and haematology of broilers fed baobab and Moringa leaf meal as premix. *Asian Research Journal of Agriculture*, *7*(3), 1-6.

Leone, A., Spada, A., Battezzati, A., Schiraldi, A., Aristil, J., & Bertoli, S. (2015). Cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of *Moringa oleifera* leaves: An overview. *International Journal of Molecular Science*, *16,* 12791-12835.

Madavi, H.J., Deshmukh, A.P., Sarnaik, A.G., Sarnaik, P.D., & Patil, R.A. (2021). Combined effect of drumstick (*Moringa oleifera*) and lemongrass (*Cymbopogon citratus*) on growth performance of broilers. *The Pharma Innovation Journal*, *10*(1), 112-114.

Meshram, P. B., Patil, R.A., Padghan, P.V., Parade, AK, Shinde, SS, & Gaikwad, BS (2019). Studies on response of broilers to diet containing drumstick (*Moringa oleifera*) leaf meal as a natural feed additive on growth performance. *International Journal of Current Microbiology and Applied Sciences*, *8*(10), 1676-1686.

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

Mousa, M.A., Osman, A.S., & Abdel Hady, H.A.M. (2017). Performance, immunology and biochemical parameters of *Moringa oleifera* and/or *Cichorium intybus* addition to broiler chicken ration. *Journal of Veterinary Medicine and Animal Health*, *9*(10), 255-263.

Movahhedkhah, S., Rasouli, B., Seidavi, A., Mazzei, D., Laudadio, V., & Tufarelli, V. (2019). Summer savory (*Satureja hortensis* L.) extract as natural feed additive in broilers: Effects on growth, plasma constituents, immune response, and ileal microflora. *Animals*, *9,* 87.

Omar, E.M., Mohamed, W.H.A., Wahed, H.M.A. &Ragab, MS (2020). Addition of *Moringa oleifera* leaves powder and medium chain fatty acids in the diets and their effect on productive performance of broiler chickens. *Egyptian Journal of Nutrition and Feeds, 23*(2), 273-288.

Rivera, L., Moron, R., Sanchez, M., Zarzuelo, A., & Galisteo, M. (2008). Quercetin ameliorates metabolic syndrome and improves the inflammatory status in obese Zucker rats. *Obesity* (*Silver Spring*), *16,* 2081-2087.

Sarkar M.S.K., Rana, M.M., Khatun, H., Faruque, S., Sarker, N.R., Sharmin, F., & Islam, M.N. (2017). Moringa leaf meal as natural feed additives on the growth performance and meat quality of commercial broiler chicken. *Asian Journal of Medical and Biological Research, 3*(2), 240-244.

Sarwatt, S.V., Kapange, S.S., & Kakengi, A.M.V. (2002). Substituting sunflower seed-cake with *Moringa oleifera* leaves as supplemental goat feed in Tanzania. *Agroforestry Systems*, *56,* 241-247.

Snedecor, G.W., & Cochran, W.G. (1994). *Statistical Methods*. 8th Edn. The Iowa State University Press, Ames, Iowa, USA.

Stohs, S.J., & Hartman, M.J. (2015). Review of the safety and efficacy of *Moringa oleifera*. *Phytotherapy Research*, *29,* 796-804.

Teteh A., Lawson, E., Tona, K., Decuypere, E. & Gbeassor, M. (2013). *Moringa oleifera* Leave: Hydro-alcoholic extract and effect on growth performance of broilers. *International Journal of Poultry Science*, 12(7), 401-405.