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Effect of *Moringa oleifera* Leaf Extract on Performance, Hemato-biochemical Parameters and Economics of Broiler Production

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ABSTRACT

Background: This study was conducted to evaluate the effect of *Moringa oleifera* leaf extracts supplementation on performance, hemato-biochemical parameters and economics of broiler chickens.

Methods: Different dietary treatments were; basal diet with no supplement (NC- negative control) and basal diet supplemented with antibiotics (PC-positive control), aqueous extract of 1.5% Moringa powder (MOAQE), ether extract of 1.5% Moringa powder (MOEE) and alcoholic extract of 1.5% Moringa powder (MOALE). The effect of these supplements on feed intake, weight gain, growth rate, FCR, hemato-biochemical parameters and on economic return was assessed in a five-week study.

Result: The FCR of Moringa extract supplemented and PC group was significantly better than NC group. Cholesterol and triglyceride value of Moringa extract group was significantly ($P<0.05$) lower than PC and NC group. Profit and profit index of PC and MOAQE group was significantly ($P<0.05$) higher than other groups. The findings of this study indicated that Moringa extract improved weight gain, feed efficiency and economic returns in broiler chickens and may be used as phytogenic growth promoter in broiler production.

Key words: Broiler production, Growth performance, Haemato-biochemical, Moringa.

INTRODUCTION

Poultry farming is gaining popularity among all livestock enterprises; it constitutes an important pillar of food security improvement as well as socio-cultural and economic development in most countries. Poultry plays very important role for humans through food supply, income and employment generation. Food and agriculture organization FAO (2010) reported that broiler chicken farming has grown into a complete industry with rapid development due to the increasing and rapid demand for chicken meat especially when meat products from other farm animals have high retail prices. Antibiotics are added in poultry drinking water for prevention and control of bacterial contamination and as growth enhancer. The merits of such practice are to maintain good health, reduce mortality of birds and support maximum growth and feed utilization and increased gain (Murwani and Murtini, 2009). However, the benefits of antibiotics as growth booster have some demerits like residual effect, drug toxicity and evolution of bacteria resistance (Ogbe and John, 2012). The negative impact on consumers of meat or poultry products due to residual effects has led to the ban on the use of antibiotics as growth promoters since 2006 by the European Union.

Animal scientists are now searching safe and natural alternatives of antibiotics such as phytobiotic. Plants contain phytonutrients and phytochemicals, which are beneficial for animal growth and overall health. Supplementation of commercial herbal growth promoters improved the final body weight, growth rate, better feed conversion ratio and higher gross profit per birds (Mahanta *et al*., 2016). *Moringa oleifera* are in high demand for their nutritional and medicinal value. *Moringa oleifera* was also claimed to boost immune systems (Olugbemi *et al*., 2010). It has relatively high crude protein, low anti-nutritional factors

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and antimicrobial activity (Dahort, 1998). Moringa is a potential plant that could be used to enhance immune response and to improve intestinal health of broiler chicken (Yang *et al.,* 2006). The abundance of omega-3 and omega-6 fatty acids, gum, glycosides, stearic acid, saponins, palmitic acid and vital vitamins like vitamin A, B1, B2, B3, and C, as well as a rich source of crude protein, provide Moringa a high nutritional value. As consequently, its leaves can be easily used to enhance the growth and productivity of livestock (Penalver *et al*., 2022). *Moringa oleifera* leaves (MOL) as a functional feed additive significantly improved the body weight, feed efficiency and reduces the serum total cholesterol, triglyceride, LDL-cholesterol and increases HDL-cholesterol in supplemented birds (Dey Avijit and De Partha Sarathi, 2013). Keeping above facts in view, the present investigation was planned to study the effects of supplementation of *Moringa oleifera* leaf extract on the performance, Hemato-biochemical Parameters and Economics of broilers chickens.

MATERIALS AND METHODS

The present experiment was conducted after approvals from Institutional animal ethical committee (IAEC) vide reference number IAEC/CVSc/P-36/2019. A total of 250-day old Vencobb-430 strain chicks were randomly allocated into five dietary treatment groups with 5 replicates of 10 chicks in each group. The chicks were kept on five dietary treatments which includes a basal diet without any additive in negative control (NC) or that supplemented with antibiotics (Positive control-PC), aqueous extract of 1.5% Moringa powder (MOAQE), ether extract of 1.5% Moringa powder (MOEE) and alcoholic extract of 1.5% Moringa powder (MOALE) in basal diet. The Moringa leaves used in the study was obtained from Moringa plants at the livestock farm complex, air dried and ground in the laboratory in powder form.

For preparation of aqueous extract, Moringa powder was soaked in distilled water for 24 hours in ratio of 1:2 (weight/volume). The preparation was then filtered to separate the debris and filtrate using Whatman's filter paper no 1. The filtrate was collected and solvent was removed using rotary evaporator and the residue obtained after evaporation was stored at 4°C until mixing to the feed. Ether extract was obtained by Soxhlet apparatus by following the standard procedure.

Ethanolic extract was prepared by soaking the *Moringa oleifera* leaves powder in 70 % ethanolic alcohol for 48 hours in water bath (37°C) then put the mixture in electric stirrer for 1 hours and after that the solution was filtered by using Whatman's filter paper No.1′ and the solvent was removed from filtrate by rotary evaporator and the residue obtained after evaporation was stored at 4°C until supplementation with feed. The composition of formulated pre-starter, starter and finisher feed and their nutrient composition are shown in Table 1.

The chicks were kept on deep litter system under uniform standard management conditions with availability of clean, fresh and wholesome drinking water. Individual body weight (BW) at zero day and weekly interval was recorded till 35 days of experimental trial. Replicate-wise feed intake (FI) of chicks was recorded at weekly interval and from these data weight gain, growth rate, FCR and performance index was calculated accordingly. At the end of the 35 days, blood samples were collected from two birds per replicate making a total of ten birds per treatment for haematological analysis by using the Nihon Kohden automated hematology analyzer and biochemical parameters by biochemical kits. At the end of research trial, economic return was also calculated to search out the commercial viability of *Moringa oleifera* leaf extracts supplementation in broiler production.

The data were analysed under completely randomized design (CRD) by employing one way analysis of variance (Snedecor and Cocran, 1994) and means of different dietary treatments were compared with Duncan multiple range test.

RESULTS AND DISCUSSION

Growth performance

The body weight, weight gain, growth rate, feed intake, feed conversion ratio and performance index of broilers at different stages are presented in Table 2. At the end of 35 days trial, data revealed that body weight, body weight gain and growth rate of Moringa extract supplemented groups was significantly ($P<0.05$) higher than NC group, however, there was no significant difference with PC group birds. Present results showed that weight gain and growth rate in broilers were highest MOALE supplemented group, however, there is no significant difference in weight gain and growth rate of moringa extract supplemented groups. The present findings of better body weight, body weight

Table 1: Composition of basal diets (per 100 kg).

Ingredient (kg)	Pre-starter	Starter	Finisher
Maize	54.2	55.50	59.3
Soybean meal	34.3	31.30	26.6
Rice polish	2.0	2.20	3.1
Vegetable fat	2.7	3.9	4.5
Sodium bicarbonate	0.55	0.42	0.44
Limestone powder	0.80	0.80	0.80
Common salt	0.25	0.25	0.25
Mustard deoiled cake	1.6	1.7	1.0
DDGS*	3.0	3.4	3.5
DL-Methionine	0.25	0.18	0.16
Lysine	0.2	0.2	0.2
Vitamin premix[1]	0.05	0.05	0.05
Mineral premix[1]	0.10	0.10	0.10

* Dried distillers grain soluble **Supplies per kg diet: Vitamin A, 12,500 IU; Vitamin D_3, 2200 IU; Vitamin E, 22 mg; Vitamin K, 3 mg; Vitamin B_2, 8 mg; Vitamin B_6, 2.4 mg; Vitamin B_{12},11 µg; Niacin, 28 mg; Pantothenic acid, 12 mg; Folic acid, 1.5 mg; Mn, 85 mg; Zn, 70 mg; Fe, 50 mg; Cu, 10 mg; I, 1.2 mg; Se, 0.2 mg; Co, 0.25 mg.

gain and growth rate of broilers due to Moringa leaf extracts supplementation are in agreement with the reports of Essein *et al*. (2022), Alabi *et al*. (2020), Esiegwu (2019) and Faluyi and Agbede (2018) who reported significantly (P<0.05) higher final body weight, body weight gain and growth rate in Moringa aqueous extract supplemented broiler chickens in comparison to control group birds. Hussein and Jassim (2019) and Teteh *et al.* (2013) also recorded significantly (P<0.05) higher final body weight and body weight gain with alcoholic and aqueous extract of *Moringa oleifera* as compared to control group broiler chickens. Significantly (P<0.05) higher body weight, body weight gain and growth rate in Moringa extract supplemented group was also observed by Paul *et al.* (2018), Allam *et al.* (2016) and Akhouri *et al.* (2013).

The feed intake of MOAQE and PC group was significantly (P<0.05) lower as compared to MOEE, MOALE and NC group, however, highest feed intake was recorded for NC group birds. During finisher phase feed intake of NC group was significantly (P<0.05) higher than PC and Moringa extract supplemented groups. The lower feed intake in MOAQE and PC groups than control might be due to better utilization of nutrients in treatment groups that help to meet the energy requirement of birds by lesser quantity of feeds because the feed intake of birds depends mainly on energy requirements.

Similar findings on feed intake are noticed by Alabi *et al*. (2020), Hussein and Jassim (2019), Paul *et al.* (2018) and Albi *et al.* (2017) who recorded significantly (P<0.05) less feed intake in groups supplemented with Moringa extract as compared to control group birds. AbouSekken (2015) also reported lower feed intake in aqueous Moringa extract supplemented group in comparison to control group.

Contrary to these findings, Adli (2020), Esiegwu (2019) and Faluyi and Agbede (2018) reported that aqueous extract of Moringa had no significant (P>0.05) effect on feed intake of broiler birds.

All the treatment groups showed significantly (P<0.05) lower FCR than NC group during starter and finisher phase

Table 2: Effects of dietary supplementation of *Moringa oleifera* leaf extracts on performance of broiler chickens.

Attributes	Dietary groups					P value
	NC	PC	MOAQE	MOEE	MOALE	
Body weight, g						
0 d	55.10±0.55	55.49±0.49	55.20±0.51	55.95±0.52	55.88±0.52	0.700
21 d	927.02±13.36	928.86±13.53	953.92±12.33	955.14±15.05	954.38±13.84	0.339
35 d	1798.28±17.3^{a}	1854.82±30.5^{ab}	1881.62±21.2^{b}	1890.70±28.2^{b}	1897.52±21.3^{b}	0.027
Weight gain, g						
Pre-starter	138.97±1.97^{a}	145.82±1.61^{c}	143.70±1.44^{bc}	137.41±1.30^{a}	139.44±1.42^{ab}	0.001
Starter	732.94±11.44	727.55±11.80	755.02±10.64	761.78±13.44	759.06±12.20	0.138
Finisher	871.26±9.75^{a}	925.96±18.38^{b}	927.70±13.53^{b}	935.56±16.08^{b}	943.14±10.98^{b}	0.003
Overall	1743.18±16.8^{a}	1799.33±30.1^{ab}	1826.42±20.9^{b}	1834.75±27.8^{b}	1841.64±20.9^{b}	0.027
Growth rate						
Pre-starter	111.39±0.48^{b}	113.49±0.45^{c}	113.08±0.38^{c}	110.22±0.27^{a}	111.00±0.29^{ab}	<0.001
Starter	130.63±0.51^{b}	128.54±0.42^{a}	130.85±0.31^{b}	132.37±0.46^{c}	131.84±0.21^{bc}	<0.001
Finisher	64.13±0.74^{a}	68.37±0.47^{b}	65.47±0.70^{ab}	65.76±0.60^{ab}	66.28±0.57^{b}	0.086
Overall	188.10±0.07^{a}	188.30±0.12^{ab}	188.56±0.11^{b}	188.44±0.10^{b}	188.57±0.08^{b}	0.005
Feed intake (g/d)						
Pre-starter	141.20±2.64	140.17±2.99	141.57±2.46	140.60±2.17	140.37±2.26	0.995
Starter	1113.27±14.3^{ab}	1090.58±10.1^{a}	1103.20±11.5^{ab}	1150.02±9.1^{c}	1130.20±13.8^{bc}	0.005
Finisher	1952.48±19.6^{c}	1813.29±17.1^{a}	1781.14±16.8^{a}	1890.94±18.7^{b}	1886.84±19.8^{b}	<0.001
Overall	3206.95±35.8^{b}	3044.05±29.9^{a}	3025.91±30.3^{a}	3181.56±29.6^{b}	3157.40±35.4^{b}	<0.001
FCR						
Pre-starter	0.99±0.01	0.98±0.012	0.98±0.011	1.02±0.008	1.00±0.008	0.089
Starter	1.54±0.006^{c}	1.50±0.012^{b}	1.47±0.008^{a}	1.49±0.019^{ab}	1.49±0.012^{ab}	0.018
Finisher	2.33±0.043^{c}	1.98±0.022^{ab}	1.93±0.023^{a}	2.04±0.022^{b}	2.01±0.019^{b}	<0.001
Overall	1.78±0.023^{d}	1.65±0.011^{b}	1.61±0.008^{a}	1.69±0.012^{c}	1.67±0.009^{bc}	<0.001
Performance index %						
Pre-starter	20.46±0.26^{b}	21.10±0.18^{c}	20.30±0.19^{b}	18.95±0.13^{a}	19.46±0.13^{a}	<0.001
Starter	62.73±1.24	62.13±1.41	65.37±1.18	63.59±1.72	64.27±1.38	0.506
Finisher	77.78±1.05^{a}	95.08±2.58^{b}	98.22±1.79^{b}	93.76±2.11^{b}	95.00±1.40^{b}	<0.001
Overall	100.98±1.08^{a}	113.30±2.65^{b}	117.15±1.65^{b}	112.62±2.38^{b}	114.19±1.53^{b}	<0.001

$^{a, b, c}$Mean bearing different superscripts in a row showed a statistical difference at P<0.05.

but no significant difference was noticed during pre-starter phase. At the end of 35 d experimental feeding the FCR of MOAQE group was significantly (P<0.05) lower than MOEE, MOALE and PC group. The lower FCR in treatment groups indicate improvement in the nutrient utilization by the birds. The improved feed utilization efficiency by the Moringa extracts supplemented birds could be explained on the basis of their antioxidant, antimicrobial and immune-stimulatory role.

The lower FCR in Moringa extract supplemented groups was favoured by Hussein and Jassim (2019), Paul *et al.* (2018) and AbouSekken (2015) who reported significantly (P<0.05) lower FCR in group supplemented with aqueous Moringa extract as compared to control group. Karthivashan *et al.* (2015), Teteh *et al.* (2013) and Akhouri *et al.* (2013) also recorded significantly (P<0.05) lower FCR in Moringa extract supplemented group in comparison to control group.However, Adli (2020), Faluyi and Agbede (2018) observed no significant effect of Moringa leaf extract supplementation on FCR of broiler chickens in comparison to control group.

The performance index of MOAQE groups was similar to NC but lower than PC group broilers for first week. PI values were statistically similar among different groups during starter phase of experiment. During finisher phase, PI values of PC and Moringa extracts supplemented groups were significantly (P<0.05) higher than NC group birds. Similarly, overall, PI values of PC and Moringa supplemented groups were also significantly (P<0.05) higher than NC group birds. MOAQE group recorded highest value (117.15) of PI followed by PC (113.30), MOALE (114.19), MOEE (112.16) and NC (100.98) group birds. Similar result was observed by AbouSekken (2015) who recorded significant (P<0.05) increase in PI% in Moringa leaf extract supplemented group in comparison to Moringa leaf powder and control group birds.

The improvement in the performance of broilers chickens recorded due to the supplementation of MOLE may also be attributed to the significant quantity of vitamins, calcium, iron, and protein. The acetone extract of MO leaf contains high number of polyphenolic compounds like flavonoids, phenols, flavonols and proanthocyanidins responsible for free radical scavenging property and strong antioxidant effect (Moyo *et al.,* 2012).

Hemato-biochemical parameters

The results of hemato-biochemical parameter are shown in Table 3. The result showed that there was no significant differences in RBC count of all groups but RBC count of Moringa extract supplemented groups was non-significantly higher than NC and PC group birds. There was no significant difference in haemoglobin, PCV and total protein among the different groups under study. Cholesterol content of MOLE and MOAQE group birds was significantly (P<0.05) higher than NC and PC group birds, however, there was no significant difference in cholesterol content of MOALE, PC and NC group. Triglyceride content of Moringa extract supplemented groups was found significantly (P<0.05) higher than NC and PC group. Among Moringa supplemented groups, MOALE group recorded lowest value of triglyceride. Blood glucose level of Moringa extract supplemented groups was found significantly (P<0.05) higher than NC and PC groups.

The present findings are in agreements with Esiegwu (2019) and Faluyi and Agbede (2018) who observed no significant (P>0.05) effect of aqueous leaf extract of *Moringa oleifera* treated broiler birds on Hb, PCV, MCH and MCHC values in comparison to control group birds. Paul *et al.* (2018) also found no significant differences across the treatments in all the haematological indices (RBC, haemoglobin and PCV) measured due to addition of 1% MOLE in diet of birds. Similarly, Allam *et al.* (2016) observed insignificant difference in values of RBC, Hb and PCV% in groups supplemented with watery and alcoholic extract of MOL in comparison to control group birds. Whereas, Hussein and Jassim (2019)observed significantly higher (P<0.05) values of red blood cell (RBC), packed cell volume (PCV%) and haemoglobin (Hb) in aqueous and alcoholic Moringa leaf extract supplemented group as compared to control group birds.Mahmood *et al.* (2015) also observed significantly (P<0.05) higher value of RBC in group supplemented with leaf extract of *Azadirachta indica* (4%), *Cichorium intybus* (2%) and *Moringa oleifera* (6%) as compared to control group birds.

Economics of broiler production

The data on economics of broiler production are presented in Table 4. The result revealed that the total feed cost of

Table 3: Effects of dietary supplementation of *Moringa oleifera* leaf extracts on hemato-biochemical parameters of broiler chickens.

Attributes	NC	PC	MOAQE	MOEE	MOALE	P-value
R.B.C. (103/μL)	2.38± 0.08	2.41± 0.038	2.47± 0.045	2.55± 0.05	2.48± 0.054	0.066
Haemoglobin (g/dl)	10.83± 0.22	10.76± 0.332	11.33± 0.21	11.52± 0.25	11.46± 0.179	0.099
PCV (%)	32.42± 0.92	32.03± 0.903	32.94± 0.59	34.92± 0.47	33.16± 0.719	0.101
Total protein (mg/dl)	3.32± 0.05	3.32± 0.07	3.31± 0.10	3.44± 0.07	3.20± 0.12	0.432
Cholesterol (mg/dl)	150.72± 3.83^{c}	151.60± 5.31^{c}	141.07±3.06^{bc}	132.19±4.22^{ab}	120.03±7.16^{a}	0.001
Triglyceride (mg/dl)	141.93± 2.40^{c}	143.69± 3.51^{c}	115.30± 5.92^{b}	122.83± 9.44^{b}	100.89±10.16^{a}	<0.001
Blood glucose (mg/dl)	260.71± 4.00^{a}	261.69± 6.23^{a}	271.85±4.95^{b}	274.70± 2.55^{b}	278.24± 5.14^{c}	0.014

$^{a, b, c}$Mean bearing different superscripts in a row showed a statistical difference at P<0.05.

Table 4: Effects of dietary supplementation of *Moringa oleifera* leaf extracts on economics of broiler chickens.

Attributes	NC	PC	MOAQE	MOEE	MOALE	P-value
Chick cost (Rs. /bird)	45	45	45	45	45	
Feed cost (Rs. /bird)	95.71±1.07^{b}	90.88±0.90^{a}	90.35±0.91^{a}	94.97±0.88^{b}	94.25±1.06^{b}	<0.001
Feed additive cost (Rs. /bird)	0.00±0.00^{a}	0.61±0.006^{b}	1.21±0.01^{c}	9.54±0.09^{e}	7.89±0.09^{d}	<0.001
Total expenditure (Rs. /bird)	146.71±1.07^{b}	142.49±0.90^{a}	142.56±0.92^{a}	155.52±0.97^{c}	153.14±1.15^{c}	<0.001
Sale price per bird	161.85±1.55^{a}	166.93±2.75^{ab}	169.35±1.91^{b}	170.16±2.54^{b}	170.78±1.90^{b}	0.027
Profit (Rs. /bird)	15.14±0.79^{a}	24.45±1.87^{b}	26.79±1.15^{b}	15.65±1.65a	17.64±1.03^{a}	<0.001
Profit index	0.09±0.004^{ab}	0.14±0.01^{c}	0.16±0.01^{c}	0.09±0.01^{a}	0.10±0.01^{b}	<0.001

$^{a, b, c}$Mean bearing different superscripts in a row showed a statistical difference at P<0.05.

group NC, MOEE and MOALE was found significantly (P<0.05) higher than PC and MOAQE group birds. All extract treated groups showed significantly (P<0.05) higher additive cost in comparison to NC and PC group broilers. The total expenditure was also significantly (P<0.05) higher in MOEE (Rs.155.52) and MOALE (Rs.153.14) group as compared to control (Rs.146.71) while PC (Rs.142.49) and MOAQE (Rs.142.56) group had significantly less values. Sale price per bird of Moringa extract supplemented groups was significantly (P<0.05) higher than NC group but statistically similar to PC group birds.

The profit of PC and MOAQE group birds was found significantly (P<0.05) higher than MOEE, MOALE and NC group birds. The profit index was recorded significantly (P<0.05) higher values in MOAQE group than NC but similar to PC group birds. The MOEE and MOALE group profit index were like NC group broiler birds.

In agreement to our finding AbouSekken (2015) reported improvement in the average values of net revenue, economic efficiency and relative economic efficiency due to feeding broiler low protein diet supplemented with Moringa leaf extracts compared with control. Portugaliza and Fernandez (2012) also observed significantly (P<0.01) higher return of investment in Moringa extract treated group than the control group. Ayo-Ajasa *et al.* (2016) recorded significantly (P<0.05) the highest feed cost in control group and the least cost was recorded in 5% Moringa leaf meal supplemented group.

CONCLUSION

Moringa oleifera leaf extract improved weight gain, feed efficiency and economic returns in broiler chickens and may be used as phytogenic growth promoter in broiler production.

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Conflict of interest

The authors declare that there is no conflict of interest.

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