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Research Article
Growth Performance and Haematological Characteristics of Broiler Finisher Birds Fed Three *Moringa* Plant Parts as Additive From 5-8 Weeks

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Abstract

Background and Objective: The addition of different plant parts as a supplement in the diets of poultry has been reported to have some effects on animal physiology and biochemical functions. This study evaluated the growth performance and haematological profiles of broiler finisher chickens fed leaf meal, raw and toasted seed meals of *Moringa* from 5-8 weeks. **Materials and Methods:** A total of 96 day-old chicks were allotted to 4 treatment groups of 8 birds each in a completely randomized design with 3 replications. The trial lasted for 28 days for the finisher phase. **Results:** The result showed significant differences ($p<0.05$) in average final weight gain, average daily weight gain, average daily feed intake and feed conversion ratio. There was a highly significant reduction in serum cholesterol, HDLP and LDLP among the birds fed *Moringa* leaf meal. It was concluded by the study that different *Moringa* plant parts exert different effects on the animal probably due to the contents of different biochemical compounds. The leaf meal was notably effective in the reduction of serum lipids. The birds fed the toasted *Moringa* seeds showed significantly higher weight gains than all other treatments. **Conclusion:** Therefore it can be concluded that *Moringa* plant-based extracts could effectively replace the use of commercial additives, hence its use is recommended to reduce production costs and increase the profitability of the poultry production business.

Key words: Biochemical compounds, serum cholesterol, leaf meal, toasted, supplement, isothiocyanates, anti-hepatotoxic, clinical pathology

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Competing Interest: The authors have declared that no competing interest exists.

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

INTRODUCTION

The high costs of broiler feed and the attendant reduction in profit margins have made many farmers seek alternative methods not only to reduce feed costs but also to improve feed utilization for overall animal performance and profitability[1]. In a bid to meet the protein needs of an ever-growing human population, Nigerians rely heavily on poultry products such as broiler meat which is in high demand by households especially on weekends and during ceremonies. This has developed the live chicken and processing segment of the poultry value chain, evident in most urban markets across Nigeria. Live chicken is rated much higher than imported frozen chicken by the average consumer because of its superior taste, wholesomeness and absence of preservatives[2]. The addition of natural pigments from plants to animal diets has been reported to improve the efficiency of feed utilization[3], improved sow fertility and survival of healthy piglets[4] and improved feed utilization in poultry[1]. Besides the high contents of protein, they contain a variety of biologically active compounds that may serve as growth and health-promoting substances. These compounds include vitamins, phenolic acids, flavonoids, isothiocyanates, tannins as well as saponins[5], others are alkaloids, terpenoids and steroids[6]. *Moringa oleifera* is indigenous to Northern India and Pakistan[7] and is introduced throughout the tropics and sub-tropics becoming naturalized in many African countries.

According to Yameogo *et al.*[8], *Moringa oleifera* leaves contain 27% crude protein, 38.6% carbohydrates, 17% ether extract and 5.9 % moisture while, Anwar and Rashid[9] recorded 31.65% crude protein, 34.8% ether extract, 7.54% crude fibre 8.9% moisture and 6.53% ash for the seeds, on dry matter basis. Madalla *et al.*[10] observed that the sulfur-containing amino acids of the kernel and the essential amino acids in the leaves were of higher value than the FAO reference protein. There has been so much report on the rich nutrient profile of *Moringa oleifera*. Thus, it is said to contain the calcium equivalent of 4 glasses of milk, 4 times the vitamin A content of carrot and thrice the value of iron in spinach[11]. It has been reported that leaf powder is a source of nourishment for growing children and pregnant mothers in low-income countries[12]. Bukar *et al.*[13] also reported anti-bacterial, antifungal, anti-hepatotoxic and hypotriglyceridemic properties of *Moringa oleifera* leaf meal. Studies by Tijani *et al.*[12] recorded an optimum inclusion level of 15% for *Moringa oleifera* leaf meal. Another report by Oghenebrorhie and Oghenesuvwe[14] observed that the weight of birds fed *Moringa* leaf meal reduced significantly as inclusion levels were increased from 6-10%.

Abdulkarim *et al.*[15] reported that the inclusion of *Moringa oleifera* seed meal at 0.01% level of inclusion improved dry matter digestibility in broiler finisher birds. Similarly, Mousa *et al.*[16], Wahab *et al.*[19] reported improvements in final body weight and average body weight gain of broiler chicks fed diets fortified with *Moringa* seed powder at 0.37% for non-germinated seeds and all levels (0.25, 0.50 and 0.75%) for germinated *Moringa* seeds at 14, 28 and 42 days of age. Furthermore, Ochi *et al.*[17] recorded enhanced live body weight gains in broilers fed *Moringa* seed meal at 0.5, 1 and 2% levels of inclusion. In the same manner, Ferreira *et al.*[18] recorded improvements in growth performance parameters in broiler chicks fed diets supplemented with 50 g kg^{-1} of *Moringa* seed meal compared to the control group. Also, Wahab *et al.*[19] reported that birds fed diets containing enzyme-supplemented *Moringa* seed meal at 0.75% had better weight gain than the control group fed other enzyme-supplemented dietary treatments. In contrast, decreasing weight gains with increasing levels of inclusion of undecorticated *Moringa* seed meal at 8, 12 and 16% levels with no significant effect on the haematological parameters was reported by Anyanwu *et al.*[2]. Another study by Wahab *et al.*[19] also recorded enhanced immune response and intestinal health of broiler chicken with *Moringa* leaf powder while Chollom *et al.*[20] demonstrated that *Moringa* seed extract has strong antiviral activity against the Newcastle disease virus.

Although there are many reports on the inclusion of *Moringa oleifera* seed meal in broiler diets. It is remarkable to note that in the few studies, the inclusion level has been in micro and small amounts of between 0.01-5%. Furthermore, studies on the comparative evaluation of the leaf meal and seed meal as well as raw and heat-toasted seed meals have not been widely reported. Therefore, it has become necessary to evaluate the efficacy of its addition in poultry diets in the absence of conventional vitamin and mineral premixes, including supplemental amino acids such as methionine and lysine hence this study. Because of this, the inclusion level was increased to 2.5%. The haematological analysis is important in this study because the blood profile is an important part of clinical pathology which indicates the normal health status of an animal. The blood serum is the fluid component of the blood that is neither a clothing factor nor a cell. It is the medium upon which cellular components such as red blood cells, white blood cells, antibodies and enzyme factors, traverse around the body of the animal. Higher or lower values may indicate the body's response to the physiological condition which could be adverse or normal in the animal.

More so, since the survival of the poultry industry in the Southeast Region of Nigeria is premised on the reduction of cost of production the search for alternative additives that are capable of improving feed efficiency at minimal cost would continue. The improvement in feed utilization promotes lower feed consumption and reduces the cost of production which before now was achieved by the use of many synthetic growth promoters and probiotics, some of which may be harmful. Because of the recent concerns about the long-term health implication of prolonged use of synthetic products it becomes imperative to seek to replace these synthetic feed additives/growth promoters with natural-based products. Based on the foregoing, therefore, this study was initiated.

The objective of this study was to investigate the effect of the inclusion of *Moringa oleifera* leaf and seed cake fractions on the growth performance and haematological characteristics of broiler finisher birds.

MATERIALS AND METHODS

Study area: The experiment was carried out in the Poultry Unit of the Teaching and Research Farm of the School of Agriculture and Agricultural Technology (SAAT), Federal University of Technology, Owerri, Imo State, Nigeria between April and June 2019. Owerri is located at an altitude of 90 m.a.s.l. The mean annual rainfall, temperature and humidity are 2500 mm, 26.5-27.5 °C and 70-80%, respectively. The duration of the dry season is 3 months with an annual rainfall of more than 2000 mm and the mean annual evaporation is 1450 mm. The soil is sandy loam with an average pH of 5.5.

Research protocol: Fresh leaves of *Moringa* were harvested from within the University Campus and surrounding areas and were spread under the sun to facilitate drying for 4-5 days until the leaves become crispy while still retaining their greenish colouration. The dried leaves were then ground into a meal using a motorized electric grinding mill to produce a *Moringa oleifera* leaf meal (MOLM). Similarly, the dry seeds of *Moringa* were sorted, cleaned and divided into two batches, one batch was toasted for 10-15 min, in a frying pan using dry heat, while the other one was left raw. The toasted and raw *Moringa* seeds were then separately ground into a meal using a motorized electric grinding mill to produce *Moringa oleifera* seed cake (MOSC).

A total of 96-day-old broiler chicks of cob-stain were purchased from a distributor in Owerri. The birds were divided into 4 groups and randomly assigned to the four experimental diets in a Completely Randomized Design (CRD). Each group was further subdivided (replicated) into 3 groups of 8 birds each. They were housed in a deep litter system with wood shavings used as litter materials. Feed and water were provided *ad-libitum* during the trial period. Litter was changed periodically to reduce the build-up of pathogenic microbes as well as the observance of other routine poultry management practices. Four experimental broiler finisher diets were formulated such that the diets contained 0 (control) and 2.5% inclusion level of leaf meal, raw and toasted seed meals respectively, at the finisher phase. The composition of the experimental diets during the finisher phase is shown in Table 1.

The parameters measured were initial body weight, final body weight, weekly body weight, average daily body weight, average daily feed intake and feed conversion ratio. Birds were weighed together at the beginning of the experiment and the end of each week and the weight was recorded. The average weight per treatment was obtained by dividing the total weight of birds in the treatment by the number of birds in that treatment group. The haematological parameters measured were, Haemoglobin (Hb), Packed Cell Volume (PCV) Red Blood Cells (RBC), Mean Cell Hemoglobin (MCH) Mean Cell Volume (MCV), Mean Cell Hb Concentration (MCHC), White Blood Cell (WBC), Neutrophils, Lymphocytes (LY), Eosinophils, Monocytes, Basophils (BA), using Haematological Analyzer Sussex xp_100(Japan). The lipid samples were analyzed for Cholesterol, Triglyceride, HDL and LDL, using an automatic Biochemical Analyzer (Clinic 2000).

Haematological profile: The haematological indices were determined using standard procedures. Haemoglobin (HB) was determined by the cyanmethaemoglobin method[21], Packed Cell Volume (PCV) was determined using the micro-haematocrit method[22], Red Blood Cell (RBC), the count was determined by the Haemocytometer Method[22], Mean Cell Volume (MCV), Mean Cell Haemoglobin (MCH), Mean Cell Haemoglobin Concentration (MCHC) were calculated using the standard formula Platelets[23], White Blood Cell (WBC), Lymphocyte Monocyte, Neutrophil were determined using a Beckman-Coulter AcT 5 Diff. haematology analyser according to the manufacturer's guidelines (Beckman Coulter (UK) Ltd.). The blood serum cholesterol and triglyceride concentrations were determined according to the methods[24], using commercial kits (Spinreact, Spain). The concentration of high-density lipoprotein cholesterol (HDL) in the serum was estimated by the method[25]. The low-density lipoprotein cholesterol (LDL) was estimated as the difference between total cholesterol and high-density lipoprotein with triglyceride divided by five according to the equations described by Sahu *et al.*[26].

Table 1: Percentage composition of experimental diet at the finisher phase

Ingredients	Diet 1 (control)	Diet 2 (toasted seed cake)	Diet 3 (raw seed cake)	Diet 4 (leaf meal)
Maize	62	62	62	62
Soya bean	20	17.5	17.5	17.5
PKC	8	8	8	8
Wheat offal	4	4	4	4
Moringa plant fraction	0.0	2.5	2.5	2.5
Fish meal	2	2.75	2.75	2.75
Bone meal	3	3	3	3
Lysine	0.25	0.0	0.0	0.0
Methionine	0.25	0.0	0.0	0.0
Vit/min premix*	0.25	0.0	0.0	0.0
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100

Statistical analysis: Data on each of the parameters were subjected to Analysis of Variance using the (ANOVA) as a Completely Randomized Design (CRD). The Duncan New Multiple Range Test was used to determine differences between treatment means[27].

RESULTS AND DISCUSSION

There were significant ($p<0.05$) differences in average final weight gain, average daily weight gain, average daily feed intake and feed conversion ratio with treatment 2 (toasted seed meal) showing the highest average final body weight of 2470 g when compared to with the rest of the trial diets, with treatment 4 having the least final weight of 1990 g in Table 2. This is consistent with previous reports[14-16]. The depressed weights recorded for the leaf meal fraction could be a result of the highly fibrous nature of the leaf meal which also resulted in a lower average daily feed intake. Furthermore, the high ether extract in the seed meal may also have contributed to the higher energy level of diets containing seed meal. The results also showed that treatments 1 and 3, were statistically similar ($p>0.05$) in average daily weight gain, average feed intake and feed conversion ratio. These results are in line with Ochi *et al.*[17] and Ferreira *et al.*[18] which reported significant differences in weight gains at various levels of inclusion of *Moringa* in the diet of broiler birds. However, this contrasts sharply with the previous report by Anyanwu *et al.*[2] which recorded a significant reduction in the feed intake and weight gains among birds fed diets containing *Moringa oleifera* and *Pueraria phaseoloides* leaf meals. Abdulkarim *et al.*[15] also reported increased digestibility in dry matter digestibility in broiler finisher birds.

Treatment 4 had the least average weight gain but a higher average daily feed intake though not significantly ($p>0.05$) different. Furthermore, in terms of average daily weight gain treatments, 1 and 2 showed better performance and differed significantly ($p<0.05$) from treatments 3 and 4. Treatments 4 and 2 had higher average daily feed intake than the rest treatments although not significant ($p>0.05$). Treatment 4 differed significantly ($p<0.05$) from treatments 3 and 2 in daily feed intake. The feed conversion ratio showed that treatments 1 and 2 had a better conversion ratio although not significant ($p>0.05$). The poorer feed conversion efficiency observed in treatment 4 may result from the fibrous nature of the leaf meal fraction, the lower nutritional composition of the leaf meal and probably the absence of feed enzymes[28]. Mune *et al.*[29] demonstrated that *Moringa* seed meal contained higher vitamin and mineral and amino acid content as compared to other leaf meals. The serum lipid profile of the various treatments is presented in Table 3. The cholesterol levels of birds in T_1 (115.50 mg dL^{-1}), T_2 (112 mg dL^{-1}) and T_3 (119.50 mg dL^{-1}) were statistically similar showing no significant ($p>0.05$) differences but were statistically significant ($p<0.05$) from T_4 (95.00 mg dL^{-1}) at 63 days of age. This is in agreement with the previous reports[2], which suggest that *Moringa* seed meals had no significant effect on serum cholesterol levels. But contrasts with other study by Ferreira *et al.*[18] which reported lower total cholesterol content in broiler finisher chickens fed 0.75% MOSP (with and without) enzyme when compared to the control. Also, HDL and LDL levels were significantly lower at 46.00 and 26.50 mg dL^{-1} ($p<0.05$) for the leaf meal fraction as compared to the other treatments. Based on these results, it can be seen that *Moringa oleifera* leaf meal demonstrated a significant ($p<0.05$) reduction in serum cholesterol, HDL and LDL levels when compared to other *Moringa* plant fractions. This is in agreement with previous reports that *Moringa* leaf meal is useful in treating obesity due to its hypocholesterolemic property[13]. However, the values for the raw and toasted seed meals were not significant ($p>0.05$) in the reduction of serum lipids.

There were no significant differences in levels of PCV, RBC, HB, MCV, MCH, MCHC, WBC and LYMPH Platelet among treatments when compared with other parameters, Table 4. This is consistent with the result of Bukar *et al.*[13] which

Table 2: Performance of broiler birds from 5-9 weeks of growth

Parameter	Diet 1 (control)	Diet 2 (toasted seed cake)	Diet 3 (raw seed cake)	Diet 4 (leaf meal)	SEM
Average initial body weight (g)	1110^{b}	1260^{ab}	1210^{b}	1033^{b}	57.00
Average final body weight (g)	2340^{b}	2470^{a}	2330^{b}	1990^{c}	51.1
Average weight gain (g)	1230^{a}	1210^{a}	1120^{b}	957^{b}	22.52
Average daily weight gain (g)	43.93^{a}	43.21^{a}	40^{b}	34.17^{b}	6.51
Average daily feed intake (g)	166.7^{ab}	173.31^{ab}	168.32^{b}	177.98^{a}	8.33
Feed conversion ratio	3.79^{a}	4.01^{ab}	4.21^{b}	5.20^{b}	1.8
Mortality	-	-	-	4	-

Means across rows with different superscripts are significantly different ($p<0.05$)

Table 3: Effect of different feed treatments on lipid parameters of broilers chickens at 63 days of age

Parameters	Diet 1 (control)	Diet 2 (toasted seed cake)	Diet 3 (raw seed cake)	Diet 4 (leaf meal)	SEM	p-value
Cholesterol (mg dL^{-1})	115.50^{ba}	119.50^{a}	112.00^{ba}	95.00^{b}	6.50	0.1345
Triglyceride (mg dL^{-1})	118.00^{a}	79.50^{a}	113.50^{a}	114.50^{a}	22.59	0.6179
HDL (mg dL^{-1})	50.50^{ba}	51.00^{ba}	54.00^{a}	46.00^{b}	1.58	0.0611
LDL (mg dL^{-1})	41.00^{ba}	52.50^{a}	35.00^{b}	26.500^{b}	4.63	0.0361

Means bearing different superscript (a,b) in a column differ significantly ($p<0.05$) and SEM: Standard error of the mean

Table 4: Effect of different feed treatments on the haematological parameter of broiler chickens at 63 days of age

Parameters	Control	Toasted	Raw seed	Leaf meal	SEM	p-value
Packed cell volume (%)	26.55^{b}	26.30^{b}	36.00^{a}	34.40^{a}	0.50	<0.0001
Red blood cell ($\times 10^{12}$ L^{-1})	2.64^{b}	2.62^{b}	2.83^{a}	2.31^{c}	0.03	0.0003
Haemoglobin (g dL^{-1})	8.80^{b}	8.90^{b}	12.10^{a}	12.30^{a}	0.13	<0.0001
MCV (fl)	100.60^{b}	102.20^{a}	93.15^{c}	99.40^{b}	0.43	<0.0001
MCH (Pg)	59.95^{a}	60.80^{a}	53.50^{b}	62.20^{a}	0.6	0.0004
MCHC (g dL^{-1})	59.65^{b}	59.45^{b}	59.60^{b}	62.30^{a}	0.13	<0.0001
White blood cell ($\times 10^{9}$ L^{-1})	113.25^{bc}	120.55^{a}	117.60^{ba}	110.00^{c}	1.67	0.0187
Lymphocytes (%)	79.50^{b}	81.50^{a}	79.00^{b}	78.00^{b}	0.43	0.0066
Platelet P($\times 10^{9}$ L^{-1})	23.00^{a}	23.50^{a}	31.00^{a}	20.50^{a}	3.0	0.1868

Means bearing different superscript (a,b,c) in a column differ significantly ($p< 0.05$) and SEM: Standard error of the mean

found no significant differences in PCV, WBC and lymphocytes. However, the level of WBC recorded for T_2 was 120.55×10^{9} L^{-1} which was highly significant, while T_1, T_4 and T_3 were statistically similar implying no significant difference between them. This may mean that the inclusion of toasted *Moringa* seed meal enhanced the immunological functions in the birds. Another study by Mune *et al.*[29] recorded a WBC count range of 18 -23 ($\times 10^{3}$ mL^{-1}) which is lower than the values recorded in this trial. Also, higher WBC counts were elevated among birds fed higher contents of *Moringa* seed meal. This is supported by the zero mortality experienced among birds fed the toasted *Moringa* seed meal.

Higher levels of haemoglobin and PCV were observed in diets containing *Moringa* leaf meal. This is in agreement with other reports by Tijani *et al.*[12] which found higher PCV, haemoglobin and WBC among birds fed the control diet and 5 and 10% *Moringa* inclusion.

CONCLUSION

The result of this study demonstrated that supplementation of broiler feeds with toasted *Moringa* seed meal significantly increased daily and final weight gains in broiler finishers more than the control at a 2.5% level of inclusion. This implies that toasted *Moringa* seed meal can comfortably replace commercial feed additives in broiler finisher diets. In addition, *Moringa oleifera* leaf meal significantly reduced the cholesterol level of birds at an inclusion level of 2.5% in broiler finisher birds and therefore can serve as an effective treatment in the reduction of belly fats in chickens thereby improving the quality of the meat. It is interesting to note that the value of all lipid parameters of birds fed *Moringa oleifera* leaf meal showed a significant reduction ($p<0.05$) than other test diets. The use of *Moringa oleifera* could be a natural method of improving the lipid and haematological parameters for better meat quality and overall growth performance and health status of broiler birds without any side effects. In conclusion, this study established the effectiveness of toasted *Moringa oleifera* seed meal for optimum weight gains in broilers and *Moringa oleifera* leaf meal in the reduction of serum lipids in poultry.

SIGNIFICANCE STATEMENT

This study has discovered the potential of toasted *Moringa* seed meal as a growth promoter in broiler diets and has reaffirmed the efficacy of the leaf powder in the reduction of serum lipids. The results from this study could be beneficial

in the reduction of belly fat in broilers and improvement in overall meat quality. Furthermore, this could open a new vista to uncover the specific active compounds responsible for facilitating feed utilization and provide better insight into critical areas of natural additive and nutrient metabolism.

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