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Effects of *Moringa oleifera* Leaf Meal on Performance, Nutrient Digestibility and Carcass Quality of Broiler Chickens

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ABSTRACT

This study was carried out to determine the effects of Moringa oleifera leaf meal (MOLM) on the performance, nutrient digestibility and carcass characteristics of broiler chickens. Fresh leaves of Moringa oleifera were harvested from the premises of the Lagos State Polytechnic, Ikorodu, and Olabisi Onabanjo University, Ayetoro campus, Nigeria. The leaves were then sundried for four days and milled. A total of 200 day-old unsexed broiler chicks of similar weight (Anak strain) were sourced from Obasanjo Farms, Ibadan, South western Nigeria. The broiler chicks were randomly allotted to five treatment groups. 0%, 5%, 10%, 15% and 20% of MOLM were incorporated into the broiler starter and finisher diets which constituted the five treatment groups. Each group was replicated four times at 10 birds per replicate Feed intake values at the starter phase were significantly (p<0.05) different across the treatment groups, but statistically similar (p>0.05) at the finisher phase. The weight gain (WG) was statistically similar (p>0.05) at the starter phase but significantly (p<0.05) different at the finisher phase, with birds fed with 15% MOLM based diet having the highest WG. The feed conversion ratio of the birds were not significantly (p>0.05) different at the starter phase, but differed significantly (P<0.05) at the finisher phase. Protein efficiency ratio (PER) was significantly higher (p<0.05) in birds fed the control diet and 15% MOLM diet. Significantly higher (p<0.05) crude protein digestibility was obtained in birds fed control diet and 15% MOLM than other treatments. Carcass characteristics showed significantly higher (p<0.05) values of dressing percentage in birds fed control diet and 15% MOLM. Lower values of breast, wings, and abdominal fat were obtained in birds fed with 10% and 20%% MOLM diets than other treatments. Overall, the best significant improvement in the response indices were obtained in birds fed 15% MOLM.

Keywords: *Moringa oleifera* leaf meal (MOLM), performance, nutrient digestibility, carcass quality

INTRODUCTION

Plants are good sources of dietary fiber low fat content, particularly saturated fats and deficient in one or more of the essential amino acids. (Dousa *et al.*, 2011). Soya bean is one of the important conventional plant protein sources in the poultry industry, but its increasing price is of a great concern (Catootjie, 2009). As a result, it has become necessary to evaluate alternative protein sources, among which are the leaf meals. Presently, researches are on-going into the viability of the Moringa *oleifera* leaf meal especially in view of the quality and quantity of food nutrients in it such as crude protein, water and fat soluble vitamins, calcium, phosphorus and iron (John and Kenaleone ,2014).

Moringa oleifera is among the plants that can be integrated into livestock production feedstock to increase feed quality and availability. The plant can be used as a cheap protein supplement to improve digestibility of other diets. *Moringa oleifera* has been widely esteemed as a versatile plant due to its multipurpose uses. The leaves, fruits, flowers and immature pods of the species are edible and they form a part of traditional diet in many tropical and sub-tropical countries (Siddhuraju and Berker, 2003; Anhwange *et al.*, 2004). The leaves of *Moringa oleifera* are a good source of protein, vitamins A, B and C, and minerals such as calcium and iron (Dahot, 1988). According to Abbas (2013), Moringa leaves are the preferred part for use in animal diets as leaf meal as a result of high nutritional and medicinal qualities. Ghasi et *al.* (1999) reported that juice extracted from Moringa leaves was a potent hypocholesterolemic agent. An In-vitro study has validated the traditional use of *Moringa oleifera* leaf as an anti-cancer (Khalafalla *et al.*, 2011), anti-trypanosomal (Mekonnen *et al.*, 1999), natural anti-oxidant (Ogbunugafor *et al.*, 2011) and hepatoprotective agent (Buraimah *et al.*, 2011). Hence, as a result of the increasing price of soyabean in the poultry industry, this study was carried out to determine the effects of *Moringa oleifera* leaf meal on performance, nutrient digestibility and carcass quality of broiler chickens.

MATERIALS AND METHODS

Fresh leaves of *Moringa oleifera* were harvested from the premises of the Lagos State Polytechnic (Latitude 6^0 37/N and Longitude 3^0 53/E) and College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro, Ogun state (Latitude 6^0 55/N and Longitude 3^0 45/E), both in South western Nigeria. The leaves were harvested from the two different locations for adequate availability of MOLM throughout the period of the experiment. The major soil type in Ikorodu is Orthic Luvisol, while that of Ayetoro the area is Oxic Paleustalf of Iwo series. The mean annual rainfalls in Ikorodu and Ayetoro are 151mm and 141mm. The mean annual temperatures in Ikorodu and Ayetoro are 31^0C and 32^0C, while the humidity ranges between 72% and 78%. The harvested leaves were mixed together, dried under shade for four days and milled in a hammer mill fitted with 2mm sieve. The product so obtained was tagged *Moringa oleifera* leaf meal (MOLM).

Formulation of Experimental Diets

Five starter and five finisher diets (Tables 1 and 2) were formulated. 0%, 5%, 10%, 15% and 20% *Moringa oleifera* leaf meal (MOLM) were incorporated into the diets. Methionine and lysine were added into all formulated diets at 0.3% and 0.1% levels to ensure the amino acids were not limiting.

Experimental birds

Two hundred (200) day-old unsexed broiler chicks (Anak strain) were randomly distributed into the five treatment diet groups. Each group consisting of forty (40) chicks was replicated four times. The experiment was arranged in a completely randomized design. Feed and water were supplied *ad - libitum*, and uniform light was provided 24hr daily. The birds were vaccinated against Newcastle disease on the 28^{th} day and Gambaro (infectious bursal disease) on the 10^{th} and 35^{th} day. Also, the birds were administered with medications against around worms and coccidiosis on the 39^{th}, 41^{st} and 47^{th} days of the experiment respectively. Data on performance characteristics (feed intake, weight gain, protein efficiency ratio and feed conversion ratio) were collected on a weekly basis. The experiment was terminated at the end of the eighth week.

Chemical analyses

The proximate composition of the *Moringa oleifera* leaf meal was determined using the analytical methods of A.O.A.C (2012). The tannin, oxalate and phytate contents of the *Moringa oleifera* leaf meal were determined using the methods described by Apata (1990). In the 7^{th} and 8^{th} week of the experiment, droppings from each replicate group of birds were collected on four successive days at 24 hours interval in metabolic cages. Four birds with weights close to the average weight of each replicate group were used for this purpose. The droppings collected were weighed fresh, placed in aluminum foil, dried to constant weight at 100^0C and analyzed for apparent retention using the formula:

$$\frac{\text{Nutrient intake} - \text{Nutrient in Droppings}}{\text{Nutrient intake}} \times 100\%$$

Table 1: Percentage composition of broiler starter diets

Ingredients	Control	5% MOLM	10%MOLM	15%MOLM	20%MOLM
Maize	54.90	56.79	50.79	49.79	42.60
Soybean meal	20.00	13.00	13.00	12.00	12.00
Groundnut cake	10.00	12.00	14.00	12.00	10.00
Moringa	-	5.00	10.00	15.00	20.00
Fish meal	2.50	2.50	2.50	2.50	2.50
Wheat offal	4.00	3.00	2.00	2.00	3.00
Brewer Dried grains	2.70	3.00	3.00	1.75	2.00
Palm oil	1.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.10	0.10	0.10	0.10	0.10
Crude protein (%)	22.89	22.79	22.74	22.76	22.54
Metabolizable Energy (Kcal/kg)	3101.21	3104.12	3024.35	3011.71	3001.40

MOLM= Moringa leaf meal. 0.50 premix supplied, per kilogram of diet: vitamin A, 12,000 IU; vitamin D3, 2,000 IU; vitamin E, 50 IU; vitamin B1, 1 mg; vitamin B2, 3 mg; vitamin B6, 1 mg; vitamin B12, 10 µg; vitamin K, 2 mg; copper (cupric sulphate), 75 mg; nicotinic acid, 12 mg; pantothenic acid, 10 mg; iron, 200 mg; cobalt, 0.5 mg; manganese, 40mg; zinc, 90 mg, iodine, 1 mg; selenium, 0.2 mg; calcium, 31.25 g; sodium, 10 g

Table 2: Proximate composition of finisher diets

Ingredients	Control	5%MOLM	10%MOLM	15%MOLM	20%MOLM
Maize	59.90	61.79	55.79	53.79	46.60
Soybean meal	15.00	8.00	8.00	8.00	8.00
Groundnut cake	10.00	12.00	14.00	12.00	10.00
Moringa	-	5.00	10.00	15.00	20.00
Fish meal	2.50	2.50	2.50	2.50	2.50
Wheat offal	4.00	3.00	2.00	2.00	3.00
Brewer Dried grains	2.70	3.00	3.00	1.75	2.00
Palm oil	1.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.10	0.1	0.1	0.1	0.1
Crude protein (%)	20.01	19.97	19.89	19.86	19.87
Metabolizable Energy (Kcal/kg)	2989.11	2987.16	2911.43	2904.37	2901.41

MOLM= Moringa leaf meal. 0.50 premix supplied, per kilogram of diet: vitamin A, 12,000 IU; vitamin D3, 2,000 IU; vitamin E, 50 IU; vitamin B1, 1 mg; vitamin B2, 3 mg; vitamin B6, 1 mg; vitamin B12, 10 µg; vitamin K, 2 mg; copper (cupric sulphate), 75 mg; nicotinic acid, 12 mg; pantothenic acid, 10 mg; iron, 200 mg; cobalt, 0.5 mg; manganese, 40mg; zinc, 90 mg, iodine, 1 mg; selenium, 0.2 mg; calcium, 31.25 g; sodium, 10 g

Carcass Characteristics

At the end of the 8th week of the experiment, eight (8) birds per group were fasted overnight and slaughtered for determination of carcass characteristics. The following carcass characteristics of the broiler chickens were determined: (i) Dressed weight as percentage of live weight (ii)Eviscerated weight as percentage of live weight (iii) Eviscerated weight as percentage of dressed weight (iv) Weight of prime cuts (back, wings, thigh and drumstick as percentage of dressed weight.

Statistical analysis

All data collected were analyzed using one-way analysis of variance to test for significant differences between the performance of the birds under the different diet treatment groups Means of treatments found to differ significantly were separated using Duncan Multiple Range Test (Silva and Azevedo,2009)

RESULTS AND DISCUSSION

The results of the proximate, mineral and anti-nutritional compositions of fresh and *Moringa oleifera* leaf meal (MOLM) are presented in Table 3. The crude protein (CP), crude fibre, ash, calcium, potassium, zinc, iron, tannin, oxalate saponin and phytic acid contents were higher in MOLM than the fresh moringa leaves (FML). The high CP content in the MOLM is similar to reports of Nuhu (2010) who shade dried moringa leaves. The CP in the MOLM in this study is lower than the amount obtained in moringa seeds by Moreki and Gabanakgosi, (2014), but higher than those of Leucaena and Gliricidia leaf meals (Aye and Adegun,2013), grasses and vegetable fruits (Jabbar *et al.*,1997, Ayssiwede *et al.,* 2010). The content of anti-nutritional factors in the FML and MOLM agrees with other reports which indicated presence of tannins, phenols and alkaloids in Moringa (Wheeler *et al.,* 1994).

The performance characteristics of the birds are shown in Table 4. Feed intake values were significantly ($p<0.05$) higher in birds fed 5%,10%, 15% and 20% MOLM - based diets than those fed control diet at the starter phase, but statistically similar ($p>0.05$) at the finisher phase for the birds under all diet treatments. At the starter phase, the higher feed intake in birds fed 10%, 15% and 20% MOLM might be as a result of the relatively low energy values of the diets as reflected in their metabolizable energy values in Table 1. Birds have been reported to consume more of low energy feed to satisfy their physiological requirement (Shurlock and Forbes, 1981; Ferket and Gernat, 2006). Onu and Aniebo, 2011 reported that increasing levels of MOLM increased the feed consumption of broilers.

The weight gain (Table 4) of the birds fed with the varying levels of MOLM diets were similar ($p>0.05$) during the starter phase but significantly ($p<0.05$) differed at the finisher phase. Birds fed 15% MOLM diet at the finisher phase had the significantly ($p<0.05$) highest weight gain, while the lowest weight gain was obtained in birds fed 20% MOLM diet. This observation is similar to the findings of Ayssiwede *et al*. (2011) who assessed the effects of MOLM inclusion in poultry diets on growth performances, carcass and organs' characteristics of growing indigenous Senegal chickens. However, the similar weight gain of birds fed under the various diets at the starter phase are at variance with the reports of Limcangco-Lopez *and* Devendra, (1989) who opined that Moringa fed in high quantities (7.5 and 10%) to one-week old chicks resulted in low weight gain. The high weight gain in birds fed 15% MOLM at the finisher phase can be attributed to a likely higher intake of amino acids. However, chickens fed 20% MOLM diet in this study showed depressed performance compared with those fed other treatment diets and this observation is in agreement with the results of Olugbemi *et al.*, (2010) who reported a depressed growth in birds fed with *Moringa oleifera* leaf meal at higher levels of inclusion. The depressed weight gain of birds fed 20% MOLM might be attributed to increased intake of tannin, phytate and oxalate thereby causing nutrient imbalance and poor metabolism on the birds (Esonu, 2000; Iheukwumere *et al.*, 2008). It is likely that the high (20%) percentage inclusion of MOLM in the die resulted in higher concentrations of tannin, phytate and oxalate in the diet.

Table 3. Chemical Composition of Fresh Moringa Leaves and Moringa Leaf Meal

Variable	FML (%)	MOLM (%)
Moisture Content (%)	65.1	6.4
Crude protein (%)	6.7	22.6
Crude fibre (%)	1.2	10.1
Ether extract (%)	1.8	3.4
Ash (%)	3.8	7.9
Nitrogen free extract (%)	21.4	49.6
Calcium (mg/100g)	4.21	6.98
Iron (mg/100g)	1.76	2.98
Potassium (mg/100g)	5.45	7.09
Zinc (mg/100g)	4.42	5.89
Tannin (mg/100g)	2.34	2.92
Phytic acid (mg/100g)	41.34	42.68
Oxalate (mg/100g)	4.48	5.01
Saponin (%)	6.41	6.76

FML= Fresh moringa leaves; MOLM= Moringa leaf meal

Table 4: Performance characteristics of broilers fed with moringa leaf meal

	Diets					
Variable	1	2	3	4	5	SEM
STARTER PHASE						
Average feed intake (g/bird/day)	58.83^{b}	59.22^{ab}	61.62^{a}	61.59^{a}	62.95^{b}	2.08
Average weight gain (g/bird/day)	23.67	22.61	22.92	23.55	20.86	1.12
Feed conversion ratio	2.49	2.61	2.69	2.62	3.02	0.11
Protein efficiency ratio	2.94^{a}	2.57^{c}	2.59^{c}	2.87^{b}	2.48^{d}	0.07
FINISHER PHASE						
Average feed intake (g/bird/day)	121.17	124.96	125.50	125.73	127.58	3.63
Average weight gain (g/bird/day)	49.03^{b}	47.98^{b}	47.33^{b}	52.43^{a}	40.86^{c}	3.15
Feed conversion ratio	2.47^{c}	2.67^{b}	2.74^{b}	2.47^{c}	3.16^{a}	2.29
Protein efficiency ratio	2.75^{b}	2.64^{c}	2.72^{b}	3.01^{a}	2.46^{d}	0.1

Diet 1= Control diet; Diet 2= 5% MOLM; Diet 3 = 10% MOLM; Diet 4= 15% MOLM; Diet 5= 20% MOLM

The feed conversion ratio (FCR) (Table 4) followed a similar trend as that of weight gain in the birds at the starter phase. However, at the finisher phase, the FCR was similar (p>0.05) between birds fed 15% MOLM and control diet, but significantly (p<0.05) higher in birds fed 5%, 10% and 20%MOLM respectively. A major reason adduced to the high FCR in birds fed 5% and 10% MOLM diets is a likely low availability of growth enhancing nutrients from the MOLM since its inclusion in the diets was at lower levels. However, for those fed 20% MOLM, the high FCR suggests low utilization of the feed for meat production as a result of increased intake of tannin, oxalate and phytate despite high availability of growth enhancing nutrients in the MOLM at the 20% inclusion level. The lower the FCR, the more efficient the birds are in using the feed supplied. Heat stable anti nutritional factors which include tannins, oxalate and phytate have been reported to reduce conversion of feed to meat or eggs in chickens (Akanji 2002).

According to Vaithyanathan and Kumar, (1993) tannins can form complexes with dietary proteins and enzymes. The proteins bound with tannins are most unlikely to undergo normal metabolism. Further tannin-enzyme interaction would inhibit the enzyme activity. This is also consistent with the findings of Emiola *et al.*, (2003) who reported a reduction in the efficiency of feed utilization when kidney beans - based diets containing some amounts of haemagglutinin were fed to broiler chickens. Phytate was reported by Apata (1990) to form complexes with many divalent metals, and even phosphorus thereby making them unavailable for use in poultry chickens. According to Fuglie (2009), the nutrient value of Moringa leaves can be increased for chickens through the addition of phytase to break down phytate leading to increased absorption of phosphorus. Phytase should simply be mixed with the leaves without heating. Gaia (2005) cautioned that raw Moringa in poultry diets can be dangerous if uncontrolled because of high bio-availability of protein and advised that particular care should be taken to avoid excessive protein intake. The protein efficiency ratio (PER) (Table 4) in this study was significantly higher (p<0.05) in birds fed the control diet and 15%MOLM diet at both the starter phase and finisher phase

Table 5: Nutrient digestibility of broilers fed with moringa leaf meal

Variable	Diets 1	2	3	4	5	SEM
Crude Protein (%)	64.44^{a}	60.39^{b}	61.41^{b}	64.33^{a}	58.06^{c}	1.63
Ether Extract (%)	68.71^{a}	66.13^{b}	66.36^{b}	67.92^{ab}	61.48^{c}	1.74
Crude Fibre (%)	22.15	23.10	23.59	22.88	23.10	1.86
Nitrogen Feed Extract (%)	66.77^{a}	60.47^{c}	59.55^{c}	$64. 51^{b}$	57.09^{d}	1.63

Diet 1= Control diet; Diet 2= 5% MOLM; Diet 3 = 10% MOLM; Diet 4= 15% MOLM; Diet 5= 20% MOLM, SEM= Standard error of mean

Table 6: Carcass characteristics of broilers fed with moringa leaf meal

Variable	Diets 1	2	3	4	5	SEM
Live weight (LW) g	1951.33	1870.00	1832.33	2065.67	1814.67	70.99
Dressed weight (% of LW)	69.69^{a}	63.87^{b}	61.02^{c}	69.43^{a}	60.09^{c}	0.91
Breast (% of LW)	22.30^{a}	21.26^{b}	21.06^{b}	23.89^{a}	20.15^{c}	0.94
Wings (% of LW)	9.11^{a}	9.18^{a}	8.18^{bc}	8.74^{b}	8.02^{c}	0.18
Thigh (% of LW)	11.92	12.07	11.45	11.61	11.52	0.25
Drum stick (% of LW)	11.36	11.18	10.76	10.86	11.05	0.34
Back (% of LW)	14.53^{ab}	14.96^{ab}	15.47^{a}	14.24^{bc}	13.9^{8c}	0.30
Heart (% of LW)	0.49^{a}	0.46^{ab}	0.34^{c}	0.39^{ab}	0.37^{bc}	0.04
Liver (% of LW)	1.93	2.12	2.05	1.83	1.89	0.13
Gizzard (% of LW)	2.10^{b}	2.05^{b}	2.49^{a}	2.11^{b}	2.03b	0.08
Neck (% of LW)	3.42^{ab}	3.05^{bc}	2.96^{c}	3.68^{a}	3.54^{a}	0.14
Leg colour	1.00	1.00	1.33	5.33	5.67	0.86
Fat (% of LW)	0.44^{a}	0.36^{a}	0.38^{a}	0.39^{b}	0.21^{b}	0.03
Spleen (% of LW)	0.14^{a}	0.07^{b}	0.09^{ab}	0.10^{ab}	0.09^{ab}	0.02

Diet 1= Control diet; Diet 2= 5% MOLM; Diet 3 = 10% MOLM; Diet 4= 15% MOLM; Diet 5= 20% MOLM, LW= live weight

Results on the nutrient digestibility of the birds are shown in Table 5. Significantly (p<0.05) higher values of crude protein (CP) digestibility were obtained in birds fed control and 15% MOLM diets. The CP digestibility was statistically similar (p>0.05) in birds fed 5% and 10% MOLM diets. The lowest CP digestibility was obtained in birds fed 20% MOLM diet. The ether extract digestibility was also significantly higher (p<0.05) in birds fed control and 15% MOLM diets. The crude fibre digestibility was not significantly different (p>0.05) in the birds fed other MOLM diets. The significant reductions in the nutrient digestibility in birds fed 20% MOLM diet in this study could be attributed to the high percentage of MOLM in the diet and by implication higher concentration of anti-nutritional factors in the diet. Kim *et al.,* (1976) reported that anti – nutritional factors can have *in vivo* inhibition of brush border dipeptidases which interfere with the transport of nitrogen through the absorptive cells of the gut and contribute to faecal – nitrogen losses. Lorenzon and Olsen, (1992) showed that raw plant seeds rich in toxic factors enhanced shedding of the brush border membranes and decrease in villus length in rats with a conspicuous effect on nutrient absorption. Nuhu, (2010) noticed that offering weaned rabbits a diet containing 10% Moringa leaf meal increased dry matter and protein digestibility.

Carcass characteristics of broilers fed with diets are shown in Table 6. The average live weights of the birds were similar (p>0.05) across the diets. Significantly higher (p<0.05) values of dressing percentage were obtained in birds fed control and 15% MOLM diets. This is in contrast with the findings of other research workers that MOLM did not significantly influence the carcass characteristics of livestock and poultry (Ayesiwede *et al.,* 2011; Odetola *et al.,* 2012). Lower values of breast, wings, and abdominal fat were obtained in birds fed with 10% and 20%% MOLM diets. Statistically similar (p>0.05) weights of thigh and drum stick were obtained in birds fed with the different diets. Significant higher (p<0.05) values of back and gizzard expressed as percentage of the live weight were obtained in birds fed with 10% MOLM diet while the lowest value was obtained in those fed 20% MOLM diet. The spleen and fat contents of broiler birds fed diets containing MOLM were lower than those fed with control diet. This might be attributed to the relatively lower energy value of the diets when compared to the control diet. Body fat deposit has been reported to correlate positively with energy intake (Cha and Jones 1998; Artkin and Davies 2000).

CONCLUSION

The results obtained in this study showed that broiler chickens fed 20% MOLM diet had significant (p<0.05) reductions in weight gain, protein efficiency ratio and crude protein, and significantly higher (p<0.05) value of FCR especially at the finisher phase. However, birds fed 15% MOLM diet compared favourably with those fed control diet in the response indices.

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