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Research Article

UTILIZATION OF *MORINGA OLEIFERA* LEAF AS FEED SUPPLEMENT IN BROILER DIET

Aderinola O.A.[1], *Rafiu T.A.[1], Akinwumi A.O.[2], Alabi T.A. and Adeagbo O.A.[2]
[1]Department of Animal Production and Health, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria
[2]Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria
**Author for Correspondence*

ABSTRACT
An eight week feeding trial was conducted using *Moringa oleifera* leaf meal (MOLM) as a feed supplement at five varying inclusion levels (0, 0.5, 1.0, 1.5 and 2.0%). A total of one hundred and fifty day old broiler chicken was equally and randomly allotted to the five treatments. Daily feed intake and weekly weight gain were monitored while feed conversion ratio was estimated. At the end of 8 weeks experimental period, six birds per treatment (2 per replicate) were randomly selected and starved for 24 hours. Blood samples for haematotogical and serum analysis were collected and dispensed into tubes containing Ethylene Diamine Tetra Acetic Acid as anticoagulant and another set into tube without anti-coagulant for serum analysis. Carcass separated to primal cuts and used to determine the carcass proportions, organoleptic properties and proximate compositions of the meat. Control diet had higher total weight gain and feed conversion ratio than MOLM based diets. Haematological parameters were significantly ($P<0.05$) reduced though fall within the normal range recommended. Serum parameters were less affected except triglyceride and cholesterol that were significantly decreased as the inclusion level increased. Organoleptic properties and proximate composition of the meat samples were significant ($P<0.05$) but no definite trend was followed except fat content which decreased as the inclusion increased. The utilization of MOLM in broiler diet as a supplement could be adopted when the motive is production of broiler meat with low fat content or deposit.

Key Words: *Moringa, Broiler, Performance, Haemathology and Meat Quality*

INTRODUCTION
Feeds and feeding is an integral part of poultry production that claim between 70-75% cost of production and at the same time dictates the production strength and quality based on the observed feeding regime and feeding quality. Quality and quantity of feed ingredients utilized in feed formulation are the determinant of feed quality. These ingredients could be grouped as main (bulk), supplement (small) or micro (minute) ingredients depending on their inclusion rate. However they are all inevitable for good performance of the animals.
Leaf meal is generally observed to be a non conventional feed ingredient and plant protein source. It also provide some necessary vitamins, minerals and oxycarotenoids which causes yellow colour of broiler skin, shank and egg yolk (Opara, 1996).
Moringa oleifera belongs to the single genus monogeneric family Moringaceae and is well distributed in Africa and Asia (Francis *et al*., 2005). Kakuji *et al*., (2003) observed that *Moringa oleifera* leaf contains 86% DM, CP 29.7%, CF 4.38%, EE 29.9%, 3,056 kcal/kg energy, Calcium 0.26%, phosphorus and negligible amount of tannin (1.23g/kg).
Moringa plant (miracle tree) has been reported to have many medicinal use such as possession of hypocholesterolemic properties (Olugbemi *et al*., 2010) and impaction of carotenoid compound into the poultry muscle and could as such substitute conventional feedstuffs as it possesses useful characteristic (Sarwalt *et al*., 2002) among others.

This study was therefore designed to explore the feeding potentials of *Moringa oleifera* leaf meal on performance, blood serum and meat quality characteristics of broiler birds.

MATERIALS AND METHODS

Site of the Experiment

The experiment was carried out at the poultry unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Pre-experimental Preparation

Moringa leaves were harvested from an 8 weeks old *Moringa oleifera* tree cut back from the pasture unit of the farm.

They were allowed to wilt on the field before it is being processed into hay by air drying under a shed. This was later sun dried over a period of 24hours at a day to milling to attain a moisture content of about 10% and to ensure its ease of milling. They were milled and then kept in an air tight container till time of use. Other test ingredients were processed accordingly.

Table 1: Proximate Composition of *Moringa oleifera* Leaf Meal (MOLM)

Nutrient	*Moringa oleifera* leaf meal (MOLM)
Dry matter	94.60
Crude protein (%)	28.00
Crude fibre (%)	7.10
Ether extract (%)	5.90
Nitrogen free extract (%)	46.80
Ash (%)	12.20
Calcium (%)	2.50
Phosphorus (%)	0.30
Metabolizable energy (MJ/kg)	8.60

Laboratory analysis of the processed MOLM used revealed that it contained crude protein and fibre as high as 28% and 7.10% respectively.

Ether extract, nitrogen free extract and Ash were 5.9%, 46.8% and 12.2% respectively. The high crude protein and other components obtained from the laboratory suggested it to be a good and promising feed resource.

Experimental Diet

Five diets were formulated such that *Moringa oleifera* leaf meal was used as a supplement and replacement for soybean meal at 0, 0.5, 1.0, 1.5 and 2.0% levels for diets 1,2,3,4, and 5 respectively different inclusion levels.

Below is the feed composition used for the starter and finisher phase.

Table 2: Composition of experimental diets for starter and finisher phases (%)

Ingredients	**Starter diets**					**Finisher diets**				
	T1	**T2**	**T3**	**T4**	**T5**	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	50.00	50.00	50.00	50.00	50.00	45.00	45.00	45.00	45.00	45.00
Whear offal	8.30	8.30	8.30	8.30	8.30	10.30	10.30	10.30	10.30	10.30
Soyabean meal	10.00	9.50	9.00	8.50	8.00	8.00	7.50	7.00	6.50	6.00
MOLM	0.00	0.50	1.00	1.50	2.00	0.00	0.50	1.00	1.50	2.00
Corn bran	12.00	12.00	12.00	12.00	12.00	17.00	17.00	17.00	17.00	17.00
*Fixed ingredients	19.70	19.70	19.70	19.70	19.70	19.70	19.70	19.70	19.70	19.70
Cal. Crude Protein	21.53	21.44	21.25	21.16	21.06	20.48	20.39	20.21	20.11	20.03
Cal. Crude fibre	10.19	10.19	10.58	10.98	11.01	10.69	10.82	11.08	11.48	11.48
Energy (kcal/kg)	2889.5	2889.5	2890.1	2891.2	2890.1	2683.5	2683.1	2683.6	2684.2	2683.7

**Fixed ingredients in every 100kg: Fish (72%cp) 4.00, GNC 10.00, Bone meal 3.00, Oyster shell 2.00,Premix 0.25, Salt 0.25, Lysine 0.1 and Methionine 0.1*

Experimental Animals and Management

A total number of 150 day old chicks from a reputable hatchery were used for the experiment. The birds were divided into five (5) treatments. Each treatment was further divided into 3 replicate of 10 birds per group using completely randomize design. The birds were brooded accordingly and each replicate were fed with experimental diet from day 1.

Data Collection

Parameters of interest under performance characteristics include; Mean weight gain, Average daily weight gain, feed intake level, protein efficiency ratio and feed conversion ratio. All the group of birds was weighed weekly and their feed intake was recorded.

At the end of 8 weeks experimental period, blood samples for haematotogical and serum analysis were collected from randomly selected birds.

The blood samples were dispensed into tubes containing Ethylene Diamine Tetra Acetic Acid as anticoagulant and another set into tube without anti-coagulant for serum analysis. The following blood parameters were determined; Red Blood Cell Counts, White Blood Cell Counts, Haemoglobin concentration, Packed Cell Volume and Mean Corpuscular Haemoglobin Concentration, total protein, Albumin, triglyceride, total cholesterol, High density lipoprotein and low density lipoprotein.

Six birds per treatment (2 per replicate) of middle weight were randomly selected, starved for 24 hours and then slaughtered by severing the jugular vein and artery. Carcass separated to primal cuts then used to determine the organoleptic properties and proximate compositions of the meat as well.

Statistical Analysis

All data obtained were subjected to analysis of variance (ANOVA) using completely randomized design of SAS (2000) system.

RESULTS AND DISCUSSION

Table 3: Performance characteristics of Broiler Chicks fed *Moringa oleifera* leaf meal based diet

Parameters	0%	0.5%	1.0%	1.5%	2.0%	SEM
TWG (g)	1801.69^{a}	1621.69^{b}	1551.75^{b}	1525.50^{b}	1470.94^{b}	29.24
ADWG (g)	32.17^{a}	28.96^{b}	27.71^{b}	27.22^{b}	26.27^{b}	0.52
ADFI (g)	117.93^{a}	108.67^{c}	103.07^{e}	115.93^{b}	105.40^{d}	0.63
PER	0.777^{b}	0.805^{a}	0.790^{b}	0.901^{a}	0.842^{a}	0.03
FCR	3.67^{a}	3.75^{b}	3.72^{b}	4.26^{c}	4.01^{d}	0.11

^{abc} *Means of different superscript were significantly (P<0.05) different*

Result from Table 3 showed that birds fed diet with 0% *Moringa oleifrea* leaf meal (MOLM) gained significantly ($P < 0.05$) higher weight than birds fed MOLM based diets. Birds on T_2, T_3, T_4 and T_5 were observed to be comparable ($P>0.05$) in average daily weight gain but its value decreased as inclusion of MOLM increased.

This confirmed the observations made by Ash and Petaia (1992) and Olugbemi *et al*., (2010) that increasing inclusion level of leaf meals in broiler diets results in depressed growth performance.

This observation could be generally traced to increasing fibre content of the diet which may have impaired nutrient digestibility and absorption (Ige *et al.,* 2006; Onu, 2010).

It could also be attributed to the higher CP content or palatability of the control feed which enhances its acceptability and utilization.

The negative effect of the anti-nutritional factors and phytochemical compounds present in MOLM on the birds could be responsible for decreasing performance. *Moringa oleifera* leaves contain tannin at 1-23g/kg (Kakengi, 2003).

Tannin has been reported to interfere with the biological utilization of protein and to a lesser extent available carbohydrate and lipids (Esonu, 2001). Leaf meals are generally bitter in taste, therefore, the inclusion of MOLM in the diets could have resulted in reduced palatability and thus reduce feed intake of the broiler diets.

Omekam (1994) observed that unpalatability nature of a feedstuff will consequently prevent chicks from consuming adequate quantity of the feed.

There was a significant increase in the feed conversion ratio of the birds fed MOLM based diets than birds that are fed without MOLM.

This suggests that birds fed MOLM based diets had lesser utilization potential of the nutrients probably because of the increased bulkiness as inclusion level increased.

Nevertheless, Du *et al.,* (2007) observed no significant depression in growth performance of 3 weeks old broilers (Arbor Acres) that were fed on diets substituted with 0.5, 1.0, 2.0 and 3.0% levels of *M. oleifera* leaf meal.

Also, Atuahene *et al*., (2008) reported no significant effect of diets containing moringa leaf meal at 0%, 2.5%, 5%, and 7.5% levels on feed intake of broiler chickens.

Table 4: Haematological and serum indices of Broiler Chicks fed *Moringa oleifera* leaf meal based diet

Parameters	0%	0.5%	1.0%	1.5%	2.0%	SEM
Haematology						
PCV (%)	37.20^{a}	36.20^{b}	34.20^{c}	31.80^{d}	31.10^{e}	0.26
RBC ($\times10^{3}/\mu L$)	2.75^{ab}	2.93^{b}	2.63^{b}	2.38^{c}	2.37^{c}	0.38
HB (g/dL)	14.10	14.20^{b}	13.20^{c}	12.60^{c}	11.80^{e}	0.11
WBC ($\times10^{6}/\mu L$)	$169.\ 60^{a}$	175.80^{d}	179.70^{c}	184.10^{b}	185.00^{a}	5.40
MCH	30.00^{a}	48.40^{d}	50.10	52.90^{a}	49.70	0.20
MCHC(mmol/L)	39.20^{b}	39.20^{b}	38.50^{c}	39.60^{a}	37.90^{d}	0.07
Serum						
Ttl Protein(g/L)	37.00	39.00	41.00	45.00	49.00	0.98
Albumin (g/L)	20.00	17.00	19.00	25.00	28.00	0.93
Globulin (g/L)	17.00	22.00	27.00	20.00	21.00	0.89
Ttl CHLT (mmol/L)	3.00^{a}	2.90^{b}	2.30^{c}	2.20^{d}	1.70^{e}	0.11
Triglyceride (mg/dL)	1.65^{a}	1.12^{b}	0.13^{d}	0.31^{c}	0.07^{e}	0.14
Urea (mmol/L)	5.00^{e}	7.00^{d}	7.10^{c}	7.20^{b}	9.70^{a}	0.34
SGPT (iU/L)	134.00	141.00	164.00	86.00	194.00	8.19
SGOT (iU/L)	92.00	115.00	127.00	72.00	164.00	7.16

^{abcde} *Means of different superscript were significantly (P<0.05) different*

Table 4 shows the haematological and serum characteristics of broiler chicks fed MOLM based diets. The mean PCV values were significantly (P<0.05) different from each other. The result was in line with Iheukwumere *et al.,* (2008) who reported significant difference (P<0.05) in various inclusion level but contradicted the report of Madubuike *et al*., (2006) who recorded no difference (P>0.05) in the PCV values among treatments, The values for PCV was significantly (P<0.05) higher for T_1 (0%MOLM) which declined as the MOLM inclusion level increased making T_5 (20%MOLM) to have the least PCV value (31.10). PCV is an index of toxicity level of the blood or suggest the presence of a toxic factor which has adverse effect on blood formation or caused reduction in the percentage of red blood cells compared to the liquid component of blood (Oyawoye and Ogunkunle, 1998). The values obtained in this study were within the normal range of (24.9- 40.7%) described by Animashahun *et al.,* (2006). Indicating that though there is presence of a toxic factor, but still all the treatment groups had nutritional adequacy, since values did not indicate mal-or under nutrition (Church *et al*., 1984). This confirms that the inclusion

of MOLM on broiler diet had little effect on the relative quantity of blood cells as compared with the total volume of blood (Health and Olusanya, 1985).

The value of RBC and Hb begins to decline from T_3. Reduction in the haemoglobin may be accompanied by a fall in the red cell count (RBC) and packed cell volume (haematocrit). The major function of the red blood cells is to transport haemoglobin, which in turn carries oxygen from the lungs to the tissues. The RBC values falls within the normal range of ($1.58\text{-}3.82\times10^6/\mu L$) described by Animashahun *et al.*, (2006). Reduced RBC is an indication that the oxygen carrying capacity of the animals' blood would be reduced. Hackbath *et al.*, (1983) reported that increased RBC values were associated with high quality dietary protein and with disease free animals. The lower RBC could be as a result of the diminishing crude protein content in the broiler diets with inclusion MOLM content. Red Blood Cells (RBC) are responsible for the transportation of oxygen and carbon dioxide in the blood as well as manufacture of haemoglobin hence higher values indicate a greater potential for this function and a better state of health (Olugbemi *et al*., 2010).

The study observed a significant ($P<0.05$) difference in the WBC parameters among treatments with T_5 (20% MOLM) having the highest value for WBC. This observation shows that the principal function of phagocytes, which is to defend against invading microorganisms by ingesting and destroying them, thus contributing to cellular inflammatory processes, was enhanced (Adedapo *et al.*, 2012) which may account for its antibacterial activity (Fahey, 2005). Thus enhancing the health condition of the experimental birds which was in line with Du *et al.*, *(*2007) who reported that dietary supplementation of *M. oleifera* may increase immune ability of broilers. This was confirmed as no mortality was recorded in treatments that were fed with MOLM based diets.

Serum biochemical indices, was significantly ($P<0.05$) different with T_5 having the highest values except total cholesterol and triglyceride. Triglycerides, total cholesterol and Urea in blood serum of broilers were significantly different ($P<0.05$) among the groups. However, SGPT and SGOT values were not found to be significantly ($P<0.05$) different. The triglycerides value of the groups fed with 0% MOLM was the highest. The cholesterol value of the group fed without MOLM diet were the highest. The low cholesterol and triglyceride content observed in the birds with MOLM would have been as a result of the hypocholesterolemic properties (Olugbemi *et al*., 2010) of MOLM included in the diets. It was observed that the cholesterol and triglyceride content decreased with increased MOLM inclusion, this may also be responsible for the low fat content observed in the meat. In other studies, animals fed diets rich in cholesterol or saturated fat had elevated carcass cholesterol and blood cholesterol levels (Blanch and Grashorn, 1995).

Table 5: Organoleptic properties and meat quality of broiler birds fed *M. oleifera* supplement

Parameter	**0%**	**0.5%**	**1.0%**	**1.5%**	**2.0%**	**SEM**
Organoleptic properties						
Colour	6.88^{a}	6.25^{ab}	6.08^{ab}	5.50^{b}	4.29^{c}	0.21
Flavor	2.75^{b}	4.75^{a}	3.50^{ab}	4.63^{a}	3.63^{ab}	0.25
Tenderness	6.25^{a}	3.25^{c}	4.13^{bc}	3.88^{bc}	5.13^{ab}	0.22
Juiciness	5.57^{a}	4.83^{ab}	5.00^{ab}	4.00^{b}	5.25^{ab}	0.21
Overall Acceptability	7.14^{a}	5.33^{b}	5.29^{b}	5.43^{b}	7.14^{a}	0.18
Proximate composition						
Crude Protein	64.53^{a}	60.59^{d}	61.25^{c}	62.18^{b}	59.55^{a}	0.19
Fat	24.34^{a}	22.34^{b}	21.40^{bc}	21.51^{bc}	20.22^{c}	0.18
Ash	9.20^{c}	10.15^{b}	10.24^{a}	9.40^{c}	9.17^{d}	0.08

^{abc} *Means of different superscript were significantly (P<0.05) different*

The organoleptic properties and meat quality of broiler birds fed MOLM based dietsis as shown in table 5. Organoleptic properties were significantly (P<0.05) different. No definite trend was followed by flavor, tenderness, juiciness and overall acceptability but the control was found to have the leading value in all parameters except flavor. Birds placed on diets supplemented with MOLM exhibit a less acceptable colouration despite the high Beta-carotene and Vitamin C (6.26mg/100ml extract) content of the leaf (Madukwe *et al*., 2013). This is in contrary to the belief that leaves meal enhances colour pigmentation because of carotinoids presence in it. Both taste and odour contribute to the flavor in poultry meat samples from MOLM based diets had a better flavor than the control. This implies that MOLM supplement gave additional characteristic taste and odour which give rise to a more acceptable flavor.
The major components of raw poultry meat are proteins, lipids and minerals at proportions between 18.4 and 23.4%, 1.3 and 6.0%, 0.8 and 1.2% respectively (Culioli *et al*., 2003). Proximate composition of the meat samples revealed that crude protein was significant but no definite trend was followed. However, all were still within the range (50.95 and 68.97%) but far above 23.4% reported by Culioli *et al*., (2003). The fat content decreased as the MOLM inclusion level increased while the mineral (Ash) content increased. This is a signal that the supplement (MOLM) has an influence on expulsion of fat from the body probably through impairment of fat synthesis (Olugbemi, 2010). This also correlates with the low cholesterol and triglyceride content observed in the serum of birds on MOLM, as well as enhances the mineral level of the product (Ogbe and John, 2012). Thus the meat produce from MOLM based diet is of relatively low fat and high mineral content, especially at 1.0% inclusion level of MOLM.

Table 6: Carcass/Primal Cuts and Organ Characteristics of broiler birds fed *Moringa oleifera* leaf meal based diets

Parameters	0%	0.5%	1.0%	1.5%	2.0%	SEM
Live weight	1767.00^{a}	1463.67^{bc}	1550.33^{b}	1378.67^{c}	1845.00^{a}	31.25
Carcass weight	1265.67^{a}	1009.00^{c}	1107.00^{b}	1122.00^{b}	1242.33^{a}	17.55
			Carcass			
Breast	23.32^{ab}	23.74^{ab}	21.07^{c}	22.27^{bc}	24.11^{a}	0.26
Wings	11.74^{a}	11.61^{a}	12.16^{a}	10.19^{b}	11.68^{a}	0.10
Thigh	13.84	14.18	14.33	14.56	14.57	0.11
Drumstick	14.04^{a}	14.14^{ab}	13.48^{b}	13.29^{b}	14.94^{a}	0.15
Back	18.29^{b}	19.43^{ab}	20.07^{a}	20.00^{ab}	19.86^{ab}	0.26
Neck	6.47^{b}	5.96^{c}	7.00^{a}	6.51^{b}	6.76^{ab}	0.81
Head	4.65	5.24	4.70	5.02	5..06	0.09
Shark	7.44^{b}	7.23^{b}	7.16^{b}	7.33^{b}	7.95^{a}	0.85
Abdominal fat	1.26^{a}	0.79^{b}	0.69^{c}	0.48^{c}	0.58^{c}	0.60
			Organs			
Liver	2.34^{b}	2.43^{b}	2.55^{b}	3.16^{a}	2.62^{b}	0.06
Lungs	0.59	0.58	0.61	0.64	0.58	0.02
Kidney	0.42^{b}	0.43^{b}	0.52^{ab}	0.57^{b}	0.58^{b}	0.02
Spleen	0.11^{b}	0.11^{b}	0.15^{a}	0.13^{b}	0.72^{c}	0.01
Gizzard	3.65^{b}	4.06^{b}	3.66^{b}	4.70^{a}	3.65^{b}	0.09
Proventiculus	0.56	0.53	0.61	0.65	0.58	0.03

^{ab}*Means on the same row with different superscripts differ significantly (P<0.05).*

Significant effect (P<0.05) of feeding *Moringa oieifera* leaf meal was observed on the carcass characteristics of the broiler chicken (Table 6). The values obtained showed variation (P<0.05) across the row of the treatments except for head and thigh. Live weight, as well as the proportions of breast, thigh, drumstick and shank had the highest value at 2.0% MOLM. Moreover, carcass weight had the highest value (1265.67%) and lowest value (1009.60%) at control and 0.5% MOLM respectively with 1.0% MOLM and 1.5% MOLM statistically (P>0.05) similar to each other. 1.0% MOLM had the highest value (7.00%) of neck proportion while least value (5.96%) was recorded at 0.5% MOLM. Also, proportion of back and wings had highest values at 1.0% MOLM. The proportion of abdominal fat decreased (P<0.05) as the inclusion level of MOLM increased. Though significance was largely recorded but no definite trend was followed, as such could not be totally attributed to the effect of MOLM supplementation except that of abdominal fat which decreased as the inclusion level increased. This could probably be attributed to the hypocholesterolemic property of the MOLM (Olugbemi *et al.*, 2010).

The organ proportions obtained show that there were significant (P<0.05) differences among liver, kidney, spleen and gizzard. Just like carcass, the significance recorded in all the parameters did not have a definite trend. Thus could not be totally attributed to the MOLM supplementation. It could be inferred from this result that utilization of MOLM in broiler diet has no influence on the organ proportion of poultry bird.

Conclusion

From the result, it could be concluded that the consumption rate or acceptability of MOLM based diet by broiler birds is very low so also the utilization potential. However, has a positive impact on blood chemistry especially the blood cholesterol as well as meat quality in term of fat deposition? Hence, utilization of MOLM in broiler diet could be adopted when the motive is production of broiler meat with low fat deposit is targeted.

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