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Evaluation of *Moringa* (*Moringa oleifera*) leaf meal as a feed additive in broiler chickens diets

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Abstract
Three hundred (300) Anak – 2000 unsexed day-old broiler chicks were used to investigate the effect of *Moringa oleifera* leaf (MLM) as a feed additive on growth performance, carcass characteristics, haematological and biochemical indices of broiler chickens. The chicks were randomly assigned to five dietary treatments consisting of four replicates of 15 chicks per replicate in a completely randomized design (CRD). The result of the growth performance shown that birds fed *Moringa oleifera* leaf meal supplemented diets showed significant (P<0.05) increases in final body weight (FBW) and total body weight gain (BWG) compared with those in the control diet. FBW increased from 2010.25g in T1 to 2474.20g in T5. The feed intake was comparable (P>0.05) among the treatment group, while feed conversion ratio (FCR) of birds fed T4 and T5 diets were superior. There was no significant difference (P>0.05) observed among the relative weights of kidney, lungs, liver, gizzard and the length of intestine. The average live weight, carcass weight, dressing percentage, thigh, breast and wing meat showed significant difference across dietary treatments. It was concluded that 0.1% MLM in broiler diets can be used as natural feed additive for enhancing growth performance, organ development, meat yield and serum cholesterol of broilers chicken.

Keywords: Performance, broiler, carcass, haemotology, serum biochemistry, *Moringa*

1. Introduction
Studies on the stimulation of the immune system and antioxidant defense in poultry production has been on focus in recent times since the introduction of the ban on the use of antibiotics as growth promoters in animal feed (Lipinski *et al.*, 2019) [15]. There is however high demand for alternative feed additives that support the animal growth without side effects such antibiotic resistance of pathogenic strains. Herbs feed additive and herbal extracts have been used in poultry production for years. Peeters *et al.* (2006) [24] and Sarker *et al.* (2017) [25] suggested that natural herbal feed additives can be used instead of antibiotic growth promoter in broiler production without effects on growth and carcass characteristics.
On of such herbal plant considered in this study is *Moringa oleifera*. The plant belongs to the single genus *Monogeneric* family *Moringaceae* and is well distributed in Africa and Asia. It has a good source of vitamins and amino acids and medicinal uses (Sarker *et al.*, 2017) [25]. The presence of adequate levels of essential amino acids, (higher than the levels present in FAO (1991) [9] reference protein) and low levels of anti-nutrients also indicate their nutritional quality. The high Pepsin soluble nitrogen (82.90%) and the low acid detergent insoluble protein (1-2%) values for the meal suggest that most of the protein on the meal is available to most animals (Makkar and Becker, 1997) [17].
Makkar and Becker, (1997) [17] also concluded that the amino acid profile of *Moringa* oleifera leaves is comparable to that of Soya-beans meal Studies also revealed that growth performance and meat quality can be enhanced by using medicinal plants and probioti cs (Sarker *et al.*, 2010 and 2011; Kim *et al.*, 2002) [27, 28, 13].
According to Yakubu *et al.* (2017) [31] leaf meal does not only serve as protein sources but also provide some necessary vitamins, minerals and also oxycarotenoids which causes yellow colour of broiler skin, shank and egg yolk. The objective of this study was to determine the effect of *Moringa oleifera* leaf as a feed additive on the growth performance, carcass characteristics and blood profile of broiler chickens.

2. Materials and Methods

2.1 Study site

The study was conducted at the State College of Agriculture, Poultry Unit of Teaching and Practical Farm, Jalingo, Ardo-Kola Local Government Area Taraba State. It is located within the Guinea Savannah zone.

It lies between latitude 8^0 53' North of the Equator and longitude die 11^0 23, East of the Guinea Savannah Zone of Northern Nigerian. The State is characterized by tropical climate marked by dry and raining season. The rainy season usually commences in the month of April and end up in October. The dry season then starts in late October and ends in April. The annual rainfall is between1000-1500mm with an average minimum temperature of 30^0C and maximum temperature of 38^0C depending on the season (Taraba State Diary, 2008) [30].

2.2 Preparation and processing of *Moringa* Oleifera Leaves

Fresh *Moringa oleifera* leaves used for this study was obtained from Zing Market and its environments in Taraba State, North Eastern Nigeria. The leaves were shade dried for a period of seven days until they are crispy to touch then processed into meal using a hammer mill sieve size of 5mm to produce the leaf meal. The leaf meal was packaged into bags and stored for subsequent inclusion into the treatment diets

2.3 Experimental Birds and Management

The study was conducted using a total of three hundred (300) unsexed day old Anak, 2000 white strain broiler chicks. They were obtained from the Oba farms Ibadan, Oyo State of Nigeria. The birds were managed on a deep litter system throughout the period of the experiment. Brooding of the chicks was done at the first seven days of the experiment, during which they were fed commercial broiler starter feed. Subsequently, formulated dietary treatments and fresh clean drinking water were offered *ad libitum*. All the necessary routine and occasional management, vaccinations and other precautions and sanitary measures were also taken throughout the study period as recommended by Oluyemi and Roberts, (2000) [23].

2.4 Experimental Design and Treatments

A total number of three hundred (300) unsexed broiler chicks randomly allotted into five dietary treatments replicated four times with 15 chicks per replicate. Treatment 1 served as control devoid of *Moringa* oleifera leaf meal, while diets 2, 3, 4 and 5 were supplemented with 0.25, 0.50, 0.75 and 1.0% respectively

Table 1: Ingredients and Percentage Composition of Broiler chicken diets

Ingredients	Starter diets (1-28 days)	Finisher diets (28 – 56 days
Maize	48.00	53.10
Soymeal	30.00	26.00
Fishmeal	3.00	3.00
Wheat offal	13.10	12.00
Palm Oil	1.00	1.00
Bone meal	3.00	3.00
Limestone	1.00	1.00
Meth.	0.20	0.20
Lysine	0.20	0.20
Salt	0.25	0.25
Premix	0.25	0.25
Total	100	100
Calculated Analysis:		
ME (kcal/kg)	2676.06	2935.07
Crude protein (%)	21.42	19.84
Crude fibre (%)	3.3	3.19
Calcium (%)	1.57	1.25
Phosphorus (%)	0.78	0.88
Lysine	0.97	0.91
Methionine	0.55	0.53

Vitamin – Mineral Premix (Bio-Mix) provided per kg the following: Vitamin A 500iu; Vitamin D_3, 888, 000iu; Vitamin E, 12, 000mg; Vitamin K_3, 15, 000mg; Vitamin B_1, 1000mg; B_2, 2000mg; Vitamin B_6, 1500mg; Niacin, 1200mg; Pantothenic acid, 2000mg; Biotin, 1000mg; Vitamin B_{12}, 3000mg; Folic acid, 1500mg; Chlorine Chloride, 60, 000mg; Manganese, 10, 000mg; Iron, 1500mg Zinc, 800mg; Copper, 400mg; Iodine, 80mg; Cobalt, 40mg; Selenium, 8000mg

2.5 Data Collection

Data were collected on feed intake gain, carcass and internal organs characteristics, haematological and biological indices. Feed intake was determined as the difference between the left over and the quantity of feed offered. Similarly, weight gain was determined as the difference between the final weight and initial weight. Feed conversion ratio was measured as an index of feed utilization for each treatment group and was calculated as the ratio of feed intake to weight gain.

Eight birds from each replicate were randomly selected for carcass and internal organs measurements. The birds were tagged according to their replicates and fasted for 8 hours to reduce the gastro-intestine contents and avoid contamination of carcass. The birds were individually weighed and slaughtered. The slaughtered birds were defeathered completely and the carcasses were plucked and the heads, necks and legs were removed and eviscerated weights were measured. The internal organs were carefully removed and weighed to determine their fresh weights. The internal organs weight was expressed as proportion of their body weight.

10mls of blood sample was collect from the randomly selected birds in each replicate using sterile syring. 5mls was placed into a sterile bottle containing anti-coagulant (EDTA-ethylene diamine tetra-acetic acid) for haematological analysis (Packed cell volume, hemoglobin and white blood Cell). While the other 5mls blood sample was placed in a sterile bottle without anti-coagulants for biochemical analysis

(total protein, globulin, albumin, urea, creatinine and, cholesterol).

2.6 Proximate Analysis
Proximate analysis of MOLM was carried out to determine the dry matter (DM) content, crude protein (CP), crude fibre (CF), either extract (EE) and total ash content according to AOAC, (2000). The nitrogen free extract (NFE) was calculated using values obtained from the proximate composition

2.7 Statistical Analysis
Data generated from all the parameters measured were subjected to one-way analysis of variance using SAS (1999) [26] version 9 software where significant difference exit, Duncan multiple range test option of same software was employed

3. Results and Discussion
3.1 Proximate composition of *Moringa oleifera* leaf used as feed additives
The result of the proximate composition of MOLM as presented in Table 2 revealed 29.68% crude protein (CP). This value agreed with the value of 28.69% reported by Odetola *et al.*, (2010) [19]. The value of ether extracts (EE) recorded confirmed the value of 5.90% reported by Aderinola *et al.* (2013) [13]. Crude Fibre (CF) 6.50% was similar to 6.51% reported by Etalem *et al.*, (2013) [18], but lower than 7.10% reported by Aderinola *et al.*, (2013) [13]. The relatively low CF content of MOLM used in this study might be due to the young age at which the leaf was harvested. Variations in nutrient composition could be as result of soil type on which the plant was cultivated and other factors such as analytical technique used for the analysis of *Moringa oleifera leaves* sample, period between sample collections and analysis. Other reasons could be the natural variation among sources samples, genetic background (cultivars, ecotype) and conservation of sample between collection and its analysis (drying, freezing etc) as was observed by Gyamfi *et al.*, (2011) [10]. The vitamin content in *Moringa oleifera* leaf showed that it contained 78.20µg vitamin A, 0.11g thiamine (B_1), 0.10mg Riboflavin (B_2), 1.4ng Niacin (B_3), 0.45mg pantothenic acids (B_5) and 0.12mg vitamin B_6, 41µg. These values are similar to those reported by Oduro *et al.* (2008). The result also revealed that the leaf meal has appreciable amount of minerals content. The value recorded were in agreement with the value reported by Moyo *et al.* (2011) [18]. The proximate, vitamin and mineral composition of *Moringa* oleifera leaf meal are within the requirement of broiler chicken recommended by Olomo, (2011) [21].

Table 3: Proximate, vitamin and mineral composition of *Moringa Oleifera* Leave Meal (MOLM) used as feed additive

Parameter	% Composition
Dry matter	96.37
Crude protein	29.68
Ether extracts	5.78
Crude fibre	6.50
Ash	10.14
Nitrogen free extracts	50.05
ME (kcal/kg)	3347.74
Vitamins (mg/100g)	
Vitamin A	78.20 µg
Thiamin B1	0.11mg
Riboflavin B12	0.10mg
Niacin B13	0.40mg
Pantothenic acid B5	0.45mg
Vitamin B6	0.12mg
Minerals (mg/100g	
Phosphorous	71.20
Calcium	87.20
Potassium	47.80
Sodium	71.00
Iron	1.20
Zinc	0.82

3.2 Growth performance of broiler chicken fed *Moringa oleifera* leaf meal as feed additive
The effect of different treatments on feed intake (FI), bodyweight (BW), average daily gains (ADG) is shown in Table 3. Birds on *Moringa oleifera* leaf meal supplemented diets showed significant ($P<0.05$) increases in final body weight (FBW) and total body weight gain (BWG) compared with those in the control diet. FBW increased from 2010.25g in T1 to 2474.20g in T5. The feed intake was comparable ($P>0.05$) among the treatment group, while feed conversion ratio (FCR) of birds fed T4 and T5 diets were superior. The result of this study was similar to the findings of Hassan *et al.* (2016) [11] and Alshukri *et al.* (2018) [3] who reported addition of *Moringa oleifera* leaf meal at levels of 0.3% and 1.0% in broiler diets improved growth performance of broiler chickens. Similarly, Elkloub *et al.* (2015) observed significant increase in body weights of broiler birds fed diet supplemented with different levels (0.2, 0.4 or 0.6%) of *M. oleifera* leaf meal. The increase in body weight and weight gain of birds fed supplemented *Moringa oleifera* leaf meal could be attributed high crude protein, amino acids, vitamins and minerals (Kakengi *et al.*, 2003 and Sarwatt *et al.*, 2004) with anti-microbial activity (Abd El-Moez *et al.*, 2014) [1]. Laxman (2016) reported improved immunocompetence and gut health of broiler chickens supplemented with *Moringa oleifera* leaf powder. 0.25, 0.50, 0.75 and 1.0%

Table 3: Growth performance of Broiler Chickens fed *Moringa* oleifera leaf meal as feed additive

	Level of *Moringa oleifera* leaf					
Parameter	T1 (0.00)	T2 (0.25)	T3 (0.50)	T4 (0.75)	T5 (1.00)	SEM
Initial body weight (g)	46.13	47.28	47.32	47.32	48.18	0.58^{ns}
Final body weight (g)	2010.25^{d}	2105.32^{cd}	2216.34^{bc}	2317.20^{ab}	2474.20^{a}	52.68^{*}
Total body weight gain (g)	1986.52^{d}	2078.82^{c}	2189.81^{bc}	2293.78^{b}	2448.02^{a}	37.85^{*}
Total feed intake (g)	5173.14	5131.22	5111.67	5121.40	5128.56	31.18^{ns}
Feed conversion ratio	2.60^{a}	2.46^{ab}	2.33^{bc}	2.23^{c}	2.09^{c}	0.07^{*}

Means on the same row with different subscripts are significantly different (P<0.05) *, SEM= Standard error mean, ns = not significant at (P>0.05)

3.3 Carcass characteristics and internal organ weights of Broiler Chickens fed *Moringa oleifera* leaf meal as feed additives

Table 4. Show the effects of *Moringa oleifera* leaf meal supplementation on dressing percentage, carcass characteristics and the weights of the heart, gizzard, liver and spleen. There were significant (P<0.05) differences in parameter measured except liver, heart, kidney and gizzard weights. The result disagrees with the finding of Alshukri *et al.* (2018) [3] reported significant influenced on the internal weights fed *Moringa oleifera* leaf meal. Birds fed *Moringa oleifera* leaf meal as feed additive recorded significantly (P<0.05) influenced on carcass weights, dressing percentage, breast, thighs and wing weights. The result of this study agreed with the findings of El-Tazi, (2010) [7] who reported increased carcass weight, dressing percentage, breast and thigh meat in birds fed *Moringa oleifera* leaf meal-supplemented diets compared with those of the control.

Table 4: Carcass characteristics and internal organ weights of Broiler Chickens fed *Moringa oleifera* leaf meal as feed additives

	Level of *Moringa oleifera* leaf					
Parameter	T1 (0.00)	T2 (0.25)	T3 (0.50)	T4 (0.75)	T5 (1.00)	SEM
Live weight	1920.81^{c}	2015.08^{b}	2126.90^{ab}	2227.76^{a}	2384.76^{a}	2.10^{*}
Dressed weight	1006.13^{d}	1081.20^{cd}	1192.22^{bc}	1293.08^{ab}	1450.08^{a}	1.20^{*}
Dressing percentage	52.38^{c}	53.55^{c}	56.01^{bc}	58.00^{ab}	60.72^{a}	0.05^{*}
Cuts parts						
Breast	383.33^{a}	345.56^{c}	$378.56.89^{b}$	388.98^{ab}	390.67^{a}	0.21^{*}
Thigh	214.67^{b}	212.56^{c}	214.07^{b}	220.83^{a}	225.00^{a}	0.12^{*}
Wing	119.11^{b}	117.27^{c}	118.11^{b}	125.27^{a}	129.44^{a}	0.07^{*}
Internal organ weight (% liveweight)						
Liver	1.77	1.78	1.67	1.76	1.87	0.04^{ns}
Heart	0.41	0.44	0.43	0.54	0.46	0.05^{ns}
Kidney	0.51	0.49	0.53	0.52	0.54	0.03^{ns}
Gizzard	1.78	186	1.77	1.76	1.79	0.02^{ns}
Intestine length	190.78	197.71	196.89	197.06	198.56	0.19^{ns}

Means on the same row with different subscripts are significantly different (P<0.05) *, SEM= Standard error mean, ns = not significant at (P>0.05)

3.4 Haematological parameter, biochemical indices and blood lipid Profile of Broiler Chickens fed *Moringa* oleifera leaf meal as feed additives

The results of the haematological indices are presented in (Table 5) the result shows no significant difference (P> 0.05) observed among the treatments for most of the parameters evaluated. White Blood Cells (WBC) count which was not significantly different (P> 0.05). This could be attributed to the ability of *Moringa* leaf meal to supply and maintain minerals and essential amino acids in the diets necessary for the normal blood cells functioning Guyton, (2000) and Oyewole *et al.,* (2013) reported that granulocyte-macrophage colony stimulating factor regulate the proliferation, differentiation and maturation of committed stem cells responsible for the production of white blood cells. The finding suggests that *Moringa oleifera* leaf have immunostimulatory ability. The PCV values also were not significantly different (P> 0.05) among treatments. This was in line with the finding of Madubuike *et al.,* (2006) [16] who recorded no different (P> 0.05) on the PCV values among treatments. The values obtained in this study were within the range of (24.9-40%) described by Animashahun *et al.,* (2006) [4]. Indicating that though there is presence of 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 diets had little effect on the relative quantity of blood cells as compared with the total volume of blood.

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 in this study range of 2.99 – 3.40 x 10^{12}/L falls within the normal range of 1.58-3.82 x 10^{12}/L described by Animashahum *et al.,* (2006) [4] these results therefore, are indications of the nutritional quality of the experimental diets in meeting the nutritional needs of the experimental birds.

The values of serum biochemical indices obtained in this study showed a non-significant (P> 0.05) difference across the treatments. This implied that the diets did not alter these parameters. However, this is in contrast with the report of Aderinola *et al.,* (2013) [13] who recorded significant (P< 0.05) difference in serum biochemical indices. Though insignificant difference (P> 0.05) was recorded across all dietary treatments, a numerical reduction in values of cholesterol was observed as the level of inclusion of MLM increased from T_1 (control) to T_5. This agrees with the report of Olugbemi *et al.,* (2010) [22] and Aderinola *et al.,* (2013) [13] who reported a reduction in serum cholesterol level with increasing level of MOLM inclusion in the diet of rats and layers respectively. The low cholesterol content observed in the birds fed MLM based diets as compared to those fed diets control diet would have been as a result of the

hypocholesterolemia properties (Olugbemi *et al.*, (2010) [22] of MLM included in the diets.

Generally, there was a pronounced intense yellowish coloration of the beak, legs, carcass cuts, abdominal fat and feathers of broilers that received dietary MLM than birds that got no MLM. This presumably may be due the high content of beta-carotene in MLM. The yellow colour observed in the body and products of the birds in this study is an indication of the efficient absorption and utilization of the pigment xanthophylls present in MLM (Etalem *et al.*, 2013) [18].

Blood lipid profile plays an important role in assess the performance and carcass quality of broilers chickens (Sarker *et al.*, 2017) [25]. Nutritional studies are been adapted to correlate some of blood parameters with the degree of fatness in broiler chickens. Very low-density lipoprotein (VLDL) is a useful parameter to infer the degree of fatness in chickens. The VLDL level in broiler chicken on *Moringa* leaf feed additive decreased progressively in which indirectly revealed the hypo cholesterolemic effect of *Moringa*. Similar finding was also reported by Olugbemi *et al.*, (2010) [22] and (Sarker *et al.*, 2017) [25]. They attributed the decrease in VLDL reason could to the hypocholesterolemic property of the *Moringa* leaf meal.

Table 5: Haematological Parameter, Biochemical indices and Blood lipid Profile of Broiler Chickens fed *Moringa oleifera* leaf meal as feed additives

Level of *Moringa oleifera* leaf						
	T1 (0.00)	T2 (0.25)	T3 (0.50)	T4 (0.75)	T5 (1.00)	SEM
Haematological parameters						
Packed cell volume (%)	28.33	29.33	28.56	27.68	26.78	0.31^{ns}
Haemoglobin (g/dl)	9.10	9.47	9.50	9.56	9.43	0.88^{ns}
Red blood cell (x 10^{12}/l)	3.10	3.40	3.70	3.56	3.43	0.21^{ns}
White blood cell (x 10^{9}/l)	113.00	111.16	112.00	113.16	113.33	4.17^{ns}
Biochemical indices						
Glucose (mmol/l)	8.13	8.34	8.45	8.30	8.45	1.03^{ns}
Urea (mmol/l)	1.95	1.22	1.28	1.45	1.21	0.22^{ns}
Creatinine (mmol/l)	42.77	42.73	41.32	41.27	43.10	3.32^{ns}
Albumin (g/l)	9.27	9.87	9.67	9.28	9.25	1.50^{ns}
Total protein (g/l)	23.73	26.50	26.52	23.42	26.18	1.25^{ns}
Blood lipid profile						
Total cholesterol (mg/dl)	152.13^{a}	143.22^{b}	132.35^{c}	132.18^{c}	131.13^{c}	0.13^{*}
TG (mg/dl)	162.18^{a}	132.12^{b}	136.22^{b}	128.20^{c}	120.13^{d}	0.13^{*}
HDL (mg/dl)	43.12	43.18	41.32	43.62	42.15	0.04^{ns}
LDL (mg/dl)	81.32^{a}	72.16^{b}	73.16^{bc}	70.13^{c}	70.92^{c}	0.07^{*}
VLDL (mg/dl)	41.32^{a}	31.32^{b}	29.00^{c}	23.15^{d}	19.52^{e}	0.02^{*}

Means on the same row with different subscripts are significantly different (P<0.05) *, SEM= Standard error mean, ns = not significant at (P>0.05) (mg/dl)

TG- Tri glyceride, HDL – High density lipoprotein, LDL- Low density lipoprotein, VLDL- Very low-density lipoprotein,

4. Conclusion

It could be concluded from the study that the use of *Moringa oleifera* leaf meal as feed additive increase weight gain, improved dressing weights and percentages and did not adversely affect internal organ and blood profile. It is therefore recommended that *Moringa oleifera* leaf meal can be used in broiler chicken diet as feed additive.

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