

AQUEOUS EXTRACT OF MORINGA (*MORINGA OLEIFERA*) LEAF (AEMOL) ON THE GROWTH, SENSORY AND HISTOLOGY PARAMETERS OF BROILER CHICKENS

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Abstract. A completely randomized design experiment was used to determine the effects of aqueous extract of *Moringa oleifera* leaf (AEMOL) on growth, sensory and histology parameters of broiler chickens. Treatment 1 served as the control (antibiotics), Treatment two was given ordinary water (AEMOL₀). Treatments 3, 4, 5 and 6 contained 30, 60, 90 and 120 ml of AEMOL per litre of water per day, respectively. Data obtained were analyzed using one-way analysis of variance and mean separation was done using Duncan's test for multiple comparisons. Results showed that the extract influenced ($P < 0.05$) the feed intake and water intake at the broiler starter phase WHILE birds on the control diet had higher values. Finisher phase results showed that final weight, weight gain, feed intake, FCR and water intake were influenced ($P < 0.05$) by the extract with birds treated with 60 ml/l of AEMOL doing better for most parameters except the FCR. All the digestibility and sensory parameters measured were also influenced ($P < 0.05$) by the extract. However, histological parameters measured were not affected ($P > 0.05$) by the extract. It could be concluded that the extract inclusion levels up to 90 ml/l can be used to replace antibiotic growth promoter without compromising the advantages of antibiotic growth promoter.

Keywords: *antibiotics, performance, replace, phytochemical*

Introduction

Broilers are a good source of protein and income to many households and therefore their production attracts the attention of many people. Poultry production remains the most extensive and widely practiced of all livestock enterprises and an important component of socio-cultural and economic development in most countries as well as in food security improvement (Alders, 2005; Dieye et al., 2010). However, the industry in the developing countries is facing some challenges which amongst others include, high feed consumption to gain ratio and high cost of feed due to high prices of feed ingredients (Abbas, 2013). Numerous attempts have been made to overcome these challenges. One of such is the use of antibiotics as growth promoters and to prevent outbreak of diseases (Manyi-Loh et al., 2018), though not without attendant problems such as drug toxicity, residual effects and development of bacterial resistance (Finley et al., 2013). This has led to the ban on the use of antibiotics as growth promoters since

2006 by the European Union, thereby shifted attention of researchers to safe alternatives such as the use plants/herbs (phytobiotic) in place of antibiotics. Some plants, such as *Moringa oleifera*, has been found to contain phytonutrients and phytochemicals as secondary metabolites which are physiologically active agents with therapeutic properties as antibiotics. Whereas the human medicinal uses of *Moringa oleifera* has been studied for many years its use in livestock production has received little attention (Nouman et al., 2013). Recently, research is focusing on its possible use to enhance growth, and nutrient utilization as a livestock fodder crop (Nouman et al., 2013). Incorporation of this herb and its products in livestock feeds and water instead of synthetic products have resulted in more rapid gain, higher production and better feed efficiency (Portugaliza and Fernandez, 2012). Other reports have indicated that *Moringa oleifera* leaves have potential prebiotic and antioxidant effects (Siddhuraju and Becker, 2003; Teixeira et al., 2014; Alabi et al., 2017). The underlying effects of the bioactive compounds in *M. oleifera* leaves are believed to induce prebiotic effects, bacterial and immune-stimulant activities (Ghazalah and Ali, 2008) resulting in increased productivity of broiler chickens.

Although there are several studies on the use of *Moringa oleifera*, however, there are scanty reports on the use of the aqueous *Moringa oleifera* leaf extract in drinking water to determine its impact on growth performance of broilers in poultry production in Minna, Middle Belt Nigeria. The aqueous extract of *Moringa oleifera* leaf is readily available, accessible and cost effective for use by the farmers and households. The present study was therefore designed to determine the effect of graded doses of aqueous *Moringa oleifera* leaf extract on growth performance, sensory and histopathology of broiler chickens and compare such with antibiotic treated broilers.

Materials and methods

This experiment was conducted at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State. Minna lies within latitude 9° 37' North and longitude 6° 32' East. The average temperature in Minna is between 19 to 37 °C with an annual rainfall of 1312 mm. The mean annual relative humidity is between 21 and 73% (Climatetemp, 2016).

Sample preparation

The leaves of *Moringa oleifera* were harvested from Minna town and environs. They were air-dried in order to ease pounding and were subsequently ground to powder using a blender. The leaf powder was soaked in water after which the solution was drained using a 1 mm mesh. The chemical composition of the extract was determined.

Experimental design, treatments and procedures

A total number of 240-day old Hubbard broiler chickens were purchased from B-not Harel hatchery Ibadan, Nigeria. The birds were kept under intensive management for eight weeks. The birds were randomly allocated to six aqueous extract of *Moringa oleifera* leaf (AEMOL) treatments. Treatment 1 served as the control (having the antibiotics), while treatment 2 was given ordinary water to serve as AEMOL₀. Treatments 3, 4, 5 and 6 contained 30, 60, 90 and 120 ml of aqueous extract of *Moringa oleifera* leaf (AEMOL) per litre per day of water, respectively (*Table 1*). The treatments

were replicated four times and each replicate had 10 birds. All necessary management requirements were strictly followed. Throughout the study, feed was given *ad-libitum*. Each treatment was fed broiler starter diet between day 1 and 21; and broiler finisher diet between days 22 and 56. Water was provided for 20 h and deprived of water for 4 h while placed on treatment dosages (so that the birds can take the treatment dosages).

Table 1. Aqueous *Moringa oleifera* leaf extracts (AEMOL) inclusion levels

Treatments	Inclusion level
AEMOL ₀₊	Control (Gendox® 1.25 mg/l)
AEMOL ₀	0 ml/l
AEMOL ₃₀	30 ml/l
AEMOL ₆₀	60 ml/l
AEMOL ₉₀	90 ml/l
AEMOL ₁₂₀	120 ml/l

Growth performance

A known quantity of the feed was given to the chickens daily for a period of four weeks with the left over collected every morning (weighed and recorded) throughout the experimental period. The daily feed intake was obtained by subtracting the left-over quantity from the initial quantity offered the previous days. The feed was weighed using weighing balance (RADWAG). The feed conversion ratio (FCR) was calculated as dry matter intake per unit weight gain.

On day 21, digestibility study was carried out. This involves feeding the animals daily with known quantity of feed. A three-day acclimatization period was allowed prior to a four-day collection period. Droppings voided by each bird were collected on a daily basis at 09.00 am. Care was taken to avoid contamination from feathers, scales, debris and feeds. Total faeces voided by each replicate were collected using a collection tray. The faeces was weighed (wet basis) and oven dried at 85 °C until a constant weight was obtained. At the end of the faecal collection the total dry faeces for each replicate was bulked, mixed and 30% of it was weighed and ground to a size that could pass through a 2-mm sieve for proximate analysis. The difference between the nutrients in the feed consumed and the faeces or nutrients in the faeces voided multiply by 100 gives the apparent digestibility coefficient of the feed, i.e. FC (feed consumed) – FV (faeces voided) X100 = apparent digestibility coefficient of the feed.

Sensory evaluation

Meat samples from the breast meat were taken from two birds randomly selected from each of the replicates of the experimental birds and 5 g of salt was added to the meat before being subjected to boiling and frying. Samples of meat from each treatment were collected after removing the flesh from the bone (manually), cut into chops of an average weight of 40 g and labelled for identification. The meat was cooked in a pot with water at a temperature of 65 °C for 30 min using a gas cooker as described by Vasanthakumar et al. (1999). Twenty trained panelists were used in the assessment procedure. They were instructed to chew a sample from each treatment. The scoring was based on parameters stated on the scoring sheet: for appearance, juiciness, flavour, tenderness and overall acceptability. Water was served to the panelists to rinse their

mouth after scoring each sample to reduce flavour carryover. The panelists scored each sample on a nine-point hedonic rating scale adopted from Vasanthakumar et al. (1999).

Histopathology

After the completion of the experimental period, the histological analysis was carried out at the histology laboratory of the Faculty of Veterinary medicine, Usman Danfodio University, Sokoto, Nigeria. Two birds per replicate were randomly selected, slaughtered, weighed and examined for respiratory tract gross lesions. Both lungs were removed and weighed. Tissue samples of the liver, lungs, kidney, intestine, spleen and heart were taken and fixed in 10% formalin. The tissues were dehydrated through a graded concentration of ethanol (70, 95 and 100%), cleared in xylene and embedded in paraffin wax. The embedded tissues were stained with hematoxyline and eosine for light microscopic examination. Lesions observed were photographed using the Vanox T Olympus photographing microscope as described by Richard et al. (2008).

Lung weight expressed as a ratio of body weight was called the lung: body weight ratio. The thoracic air sacs were assigned gross lesion scores, where 0 = clear, 1 = cloudy, 2 = cloudy with minimal caseous exudate accumulation and 3 = severe caseous exudate accumulation. A 2.5-cm longitudinal hemi-sectioned portion of trachea from each chicken was immersion-fixed in a coded container that was three-quarters full of 10% formalin saline routinely processed, stained with haematoxylin and eosin and examined under light microscope. The severity and distribution of mucosal morphological lesions (loss of cilia, epithelial cell hypertrophy and hyperplasia, inflammation and necrosis) in sections of trachea were recorded. A score was assigned to each lesion and its distribution, which was the sum of A + B, where A represents the severity of the lesion within the section and B represents the distribution of the lesion across the section. For injury distribution, scores were either 0 = no injury, 1 = focal injury, 2 = multi focal injury or 3 = diffuse injury. For each of loss of cilia, epithelial cell hypertrophy/hyperplasia, inflammatory infiltrate and necrosis, a severity score was assigned where 0 = no cells (0%) affected, 1 = < 25% of cells affected, 2 = 25 to 50% of cells affected, 3 = 50 to 75% of cells affected and 4 = > 75% of cells affected. For inflammation, 0 = none, 1 = minimal: if inflammatory cells were directed toward the luminal epithelium; 2 = mild: if inflammatory cells predominated within the epithelium, and fewer inflammatory cells were found in the lamina propria; 3 = moderate: if inflammatory cells were found scattered throughout the mucosa; and 4 = marked: if sheets of inflammatory cells filled the mucosa.

Data analysis

All data obtained were subjected to analysis of variance (ANOVA) for a completely randomized design. Where differences occurred, they were separated using Duncan's new multiple range test (SAS, 2013).

Results

Proximate and phytochemical composition of Moringa oleifera

The proximate composition of *Moringa oleifera* leaf meal analysis is presented in *Tables 2* and *3*. The dry matter, ether extract, crude protein, crude fibre, ash, and nitrogen free extract contents

Moringa oleifera leaf meal contained 0.11 µg/ml of total flavonoids, 9.97 µg/ml of total phenols, 0.26 mg/ml of alkaloids, 1.17 µg/ml of tannins and 245.3 µg/ml of saponins. The aqueous extracts of *Moringa oleifera* leaf contained 0.11 µg/ml of total flavonoids, 10.78 µg/ml of total phenol, 0.21 mg/ml of alkaloids, 5.33 µg/ml of tannins and 22.55 µg/ml of saponins. While the aqueous *Moringa oleifera* residues had 1.22 µg/ml of total flavonoids, 9.70 µg/ml of total phenols, 0.27 mg/ml of alkaloids, 3.83 µg/ml of tannins and 195.3 µg/ml of saponins.

Table 2. Proximate composition of *Moringa oleifera*

Parameters	Percentage composition (%)
Dry matter	94.25
Ether extra	5.50
Crude protein	23.80
Crude fibre	16.57
Ash content	9.75
Nitrogen free extracts	38.63

Table 3. Phytochemical composition of *Moringa oleifera* leaf meal, aqueous *Moringa oleifera* leaf extracts and *Moringa oleifera* residues

Parameter	<i>Moringa</i> preparations		
	Ground <i>Moringa oleifera</i> leaf meal	Aqueous <i>Moringa oleifera</i> leaf extracts	<i>Moring oleifera</i> residues
Total flavonoids (µg/ml)	0.11	0.11	1.22
Total phenols (µg/ml)	9.97	10.78	9.70
Alkaloids (mg/ml)	0.26	0.21	0.27
Tannins (µg/ml)	1.17	5.33	3.83
Saponins (µg/ml)	245.30	22.55	195.30

Effect of aqueous extract of Moringa oleifera leaf on growth performance of broiler chickens at both starter and finisher phases

Table 4 shows the results of the effects of aqueous extract of *Moringa oleifera* leaf on growth performance of broiler chickens during the starter and finisher phases. The initial, final, growth rate, feed conversion ratio and mortality were not influenced ($P > 0.05$) by AEMOL treatments at the starter phase. However, feed intake and water intake were influenced ($P < 0.05$) by AEMOL treatments.

Birds on the AEMOL₀ treatment had the highest feed intake and was significantly ($P < 0.05$) higher than all other treatments which had similar ($P > 0.05$) feed intake values.

Water intake results showed that birds on control and AEMOL₀ treatments had the highest water intake, which were significantly higher ($P > 0.05$) than those birds on AEMOL₃₀ treatment.

The results of the growth performance at the finisher phase showed that all parameters measured were influenced ($P < 0.05$) by AEMOL treatments except the initial weight and the water intake which were not affected. Birds on AEMOL 60 ml/l had highest final weight and feed intake and were significantly ($P < 0.05$) higher than

all the other treatments. Similarly, the weight gain results showed that birds on AEMOL 60 ml/l had significantly ($P < 0.05$) higher value than all the other treatment except for birds on the control treatment. The feed conversion ratio results showed that birds on the control treatment had the best value and was significantly ($P < 0.05$) better than all the other treatments.

Table 4. Effect of aqueous extract of *Moringa oleifera* leaf on performance of Hubbard broiler chickens at both starter and finisher phases

Parameters	Aqueous leaf extract treatments						SEM
	Control	AEMOL ₀	AEMOL ₃₀	AEMOL ₆₀	AEMOL ₉₀	AEMOL ₁₂₀	
Starter phases							
Initial weight (g)	138.75	140.00	138.75	136.25	141.25	136.25	1.58
Final weight (g)	1241.25	1311.25	1242.50	1202.50	1283.75	1300.00	23.74
Growth rate (g)	39.37	41.83	39.42	38.08	40.80	41.56	0.82
Feed intake (g)	286.76 ^b	329.69 ^a	289.26 ^b	283.14 ^b	286.18 ^b	280.68 ^b	4.19
FCR	0.26	0.28	0.26	0.27	0.26	0.25	0.01
Water intake (ml)	254.54 ^a	258.04 ^a	215.44 ^b	249.02 ^{ab}	245.19 ^{ab}	246.14 ^{ab}	5.82
Finisher phases							
Initial weight (g)	1304.72	1264.72	1311.95	1348.47	1387.85	1332.78	23.74
Final weight (g)	2350.0 ^c	2242.00 ^d	2200.00 ^e	2392.00 ^a	2367.00 ^b	2042.00 ^f	25.28
Weight gain (g)	1045.3 ^a	983.95 ^b	888.05 ^c	1043.5 ^a	979.15 ^b	708.98 ^d	25.04
Feed intake (g)	3212.47 ^{bc}	3082.50 ^c	3300.42 ^b	3549.45 ^a	3351.29 ^b	3215.42 ^{bc}	7.16
FCR	3.07 ^a	3.15 ^b	3.71 ^e	3.40 ^c	3.42 ^d	4.53 ^f	0.04
Water intake (ml)	1304.72	1264.72	1311.95	1348.47	1387.85	1332.78	11.63

^{a,b,c,d,e,f}Means within the same row with different superscripts are significantly different at $P < 0.05$; AEMOL₀₊ contained Gendox® 1.25 mg/l of water, AEMOL₀ contained 0 ml of moringa extract/l of water, AEMOL₃₀ contained 30 ml of moringa extract/l of water, AEMOL₆₀ contained 60 ml of moringa extract/l of water, AEMOL₉₀ contained 90 ml of moringa extract/l of water, AEMOL₁₂₀ contained 120 ml of moringa extract/l of water

Effect of aqueous extracts of *Moringa oleifera* leaf on apparent nutrient digestibility of Hubbard broiler chickens

Apparent nutrient digestibility results are shown in *Table 5*. The apparent nutrient digestibility results showed significant difference in all the treatments in the following order of highest to lowest: AEMOL₀, AEMOL₉₀, AEMOL₆₀, control, AEMOL₁₂₀ and AEMOL₃₀ respectively. Similar to the dry matter, the crude fibre digestibility differed significantly in all the treatments in the following order of highest to lowest: AEMOL₀, AEMOL₉₀, AEMOL₁₂₀, AEMOL₃₀, AEMOL₆₀ and control, respectively.

The ether extract digestibility results showed that the birds on AEMOL₀ treatment had the highest digestibility and their values were significantly ($P < 0.05$) higher than all the other treatments. Birds on AEMOL₃₀ and AEMOL₉₀ treatments had similar ($P > 0.05$) ether extract values. Similarly, birds on AMOLE₆₀ and AEMOL₁₂₀ treatments had similar ($P > 0.05$) ether extract digestibility. Their digestibility values were, however, lower ($P < 0.05$) than those on AEMOL₃₀ and AEMOL₉₀ treatments. Bird on the control treatment had the least ether extract digestibility and they were significantly lower ($P < 0.05$) than all the other treatments.

The crude protein (CP) digestibility results showed that birds on AEMOL₀ and AEMOL₆₀ treatments had the highest CP digestibility and their digestibility were higher ($P < 0.05$) than the ones in other treatments. Birds on AEMOL₉₀ had significantly higher ($P < 0.05$) CP digestibility than those on control, AEMOL₁₂₀ and AEMOL₃₀ which were all significantly different ($P < 0.05$) from one another.

Birds on AEMOL₀ and AEMOL₆₀ had similar ($P > 0.05$) NFE (nitrogen free ether) digestibility. Their digestibility values were significantly ($P < 0.05$) lower than those of birds on AEMOL₉₀, control, AEMOL₁₂₀, and AEMOL₃₀ treatments, which were significantly ($P < 0.05$) lower than one another in descending order.

Table 5. Effect of aqueous extract of *Moringa oleifera* leaf on apparent nutrient digestibility (%) of Hubbard broiler chickens

Parameters	Aqueous leaf extract treatments						SEM
	Control	AEMOL ₀	AEMOL ₃₀	AEMOL ₆₀	AEMOL ₉₀	AEMOL ₁₂₀	
Dry matter	79.17 ^d	83.57 ^a	65.94 ^f	82.69 ^c	82.88 ^b	70.92 ^e	1.43
Crude fibre	92.43 ^f	93.66 ^a	92.85 ^d	92.59 ^e	93.20 ^b	92.97 ^c	0.13
Ether extract	98.26 ^d	98.89 ^a	98.53 ^b	98.44 ^c	98.58 ^b	98.41 ^c	0.09
Crude protein	80.80 ^c	85.33 ^a	70.43 ^e	84.90 ^a	84.24 ^b	73.14 ^d	1.43
Nitrogen free extract	14.34 ^c	10.76 ^e	28.98 ^a	10.69 ^e	11.07 ^d	23.72 ^b	1.74

^{a,b,c,d,e,f}Means within the same row with different superscripts are significantly different at $P < 0.05$; AEMOL₀₊ contained Gendox® 1.25 mg/l of water, AEMOL₀ contained 0 ml of moringa extract/l of water, AEMOL₃₀ contained 30 ml of moringa extract/l of water, AEMOL₆₀ contained 60 ml of moringa extract/l of water, AEMOL₉₀ contained 90 ml of moringa extract/l of water, AEMOL₁₂₀ contained 120 ml of moringa extract/l of water

Effect of aqueous extract of *Moringa oleifera* leaf on sensory evaluation of Hubbard broiler chicken meat

Presented in *Table 6* are the results of the effect of AEMOL treatments on appearance, flavour, juiciness, tenderness and general acceptability. All parameters measured were influenced ($P < 0.05$) by the treatments.

The meat appearance results showed that birds on the AEMOL₀, AEMOL₃₀, and AEMOL₆₀ treatments had the best appearance ($P < 0.05$), but similar ($P > 0.05$) to meat from birds in AEMOL₀ and AEMOL₉₀ treatments. Likewise, meat from birds on the control, AEMOL₉₀ and AEMOL₁₂₀ treatments had similar ($P > 0.05$) appearance. However, the meat from birds on AEMOL₁₂₀ treatment had least value of appearance.

The results of the meat from birds on AEMOL₀, control, AEMOL₃₀, and AEMOL₆₀ treatments, their values were similar ($P > 0.05$) in flavour but those on AEMOL₀ treatment had the best flavour, and were significantly better than those on AEMOL₉₀ and AEMOL₁₂₀ treatments. Meat of birds on control, AEMOL₃₀, AEMOL₆₀, AEMOL₉₀ treatments had similar ($P > 0.05$) flavour. Meat juiciness results showed that meat from birds on control, AEMOL₀, AEMOL₃₀, AEMOL₆₀ and AEMOL₉₀ treatments were similar ($P > 0.05$) in juiciness values. However, meat of birds from control, AEMOL₃₀, treatments and AEMOL₉₀ had more ($P < 0.05$) juiciness than those of meat of birds from AEMOL₁₂₀ treatment.

Meat from birds on the AEMOL₀ treatment were more tender ($P > 0.05$) than those of birds on AEMOL₁₂₀. However, their tenderness value was similar to those of birds from control, AEMOL₃₀, AEMOL₆₀ and AEMOL₉₀ treatments.

The general acceptability results showed that meat from birds on AEMOL₀ treatment were better and more acceptable ($P < 0.05$) than those from other treatments except meat from AEMOL₃₀ treatment which had similar values. Birds on control, AEMOL₃₀, AEMOL₆₀ and AEMOL₉₀ treatments had similar ($P > 0.05$) acceptability values and they were however significantly more acceptable ($P < 0.05$) than meat from birds on AEMOL₁₂₀ treatment.

Table 6. Effect of aqueous extract of *Moringa oleifera* leaf on sensory evaluation of Hubbard broiler meat

Parameters	Aqueous leaf extract treatments						SEM
	Control	AEMOL ₀	AEMOL ₃₀	AEMOL ₆₀	AEMOL ₉₀	AEMOL ₁₂₀	
Appearance	7.05 ^{ab}	7.60 ^a	7.35 ^a	7.45 ^a	7.10 ^{ab}	6.55 ^b	0.11
Flavour	7.00 ^{ab}	7.50 ^a	7.25 ^{ab}	7.25 ^{ab}	6.65 ^{bc}	6.16 ^c	0.11
Juiciness	6.75 ^{ab}	7.45 ^a	7.15 ^a	6.65 ^{ab}	7.00 ^a	6.25 ^b	0.11
Tenderness	7.20 ^{ab}	7.85 ^a	7.70 ^{ab}	6.95 ^{ab}	7.15 ^{abc}	6.40 ^c	0.12
General acceptability	7.25 ^b	8.30 ^a	7.65 ^{ab}	7.20 ^b	7.25 ^b	6.30 ^c	0.11

^{a,b,c}Means within the same row with different superscripts are significantly different at $P < 0.05$; AEMOL₀₊ contained Gendox® 1.25 mg/l of water, AEMOL₀ contained 0 ml of moringa extract/l of water, AEMOL₃₀ contained 30 ml of moringa extract/l of water, AEMOL₆₀ contained 60 ml of moringa extract/l of water, AEMOL₉₀ contained 90 ml of moringa extract/l of water, AEMOL₁₂₀ contained 120 ml of moringa extract/l of water

Effect of aqueous extract of *Moringa oleifera* leaf on histological parameters of Hubbard broiler chickens at finisher phase

Table 7 shows the effect of aqueous extract of *Moringa oleifera* leaf on histological parameters of Liver, Lung, Kidney, Intestine, Spleen and Heart of Hubbard broiler chickens. All organs measured showed no sign ($P > 0.05$) of hypertrophy, hyperplasia, inflammation, necrosis and injury.

Discussion

The Proximate composition of *Moringa oleifera* leaf meal analysis results of dry matter (94.25), ether extract (5.50), crude protein (23.80), crude fibre (16.57), ash (9.75), and nitrogen free extract (38.63) in the present study were contrary to the values obtained by Makkar and Becker (1997) who reported the values as 2.15% of fat content, 27.29% of crude protein, 10.67% of crude fibre, 15% of ash content and 34.08% N.F.E. These differences in the value may be due to the processing methods, the period of harvesting of the plants and the climatic condition as reported by Fuglie (2001). The results also showed that *Moringa oleifera* leaf is considerably rich in protein (23.80%), crude fiber (16.57%) which is similar to the findings of Mabruk et al. (2010) and Zaku et al. (2015). However, the dry matter (94.25%) and ash (9.75%), the fat content (5.50%) and nitrogen free extract content (38.82%) contents in the present study are similar to those reported obtained by Mabruk et al. (2010) and Ogbe and John (2012).

The results also showed that aqueous processing of *Moringa oleifera* leaves do not reduce some the phytochemical properties except for saponin which were reduced. Nityanand (1997) and Akinmutimi (2004) observed similar results and reported that most processing methods employed in improving the food value of non-conventional feedstuffs do not eliminate the anti-nutritional factor substances completely.

Table 7. Effect of aqueous extract of *Moringa oleifera* leaf on histological parameters of Liver, Lung, Kidney, intestine, spleen and heart of Hubbard broiler chickens

		Treatments					
Organs	Parameters	Control	AEMOL ₀	AMOLE ₃₀	AMOLE ₆₀	AMOLE ₉₀	AMOLE ₁₂₀
		Scores	Scores	Scores	Scores	Scores	Scores
Liver	Hypertrophy	None	None	None	None	None	None
Liver	Hyperplasia	None	None	None	None	None	None
Liver	Inflammation	None	None	None	None	None	None
Liver	Necrosis	None	None	None	None	None	None
Liver	Injury	None	None	None	None	None	None
Lungs	Hypertrophy	None	None	None	None	None	None
Lungs	Hyperplasia	None	None	None	None	None	None
Lungs	Inflammation	None	None	None	None	None	None
Lungs	Necrosis	None	None	None	None	None	None
Lungs	Injury	None	None	None	None	None	None
Kidney	Hypertrophy	None	None	None	None	None	None
Kidney	Hyperplasia	None	None	None	None	None	None
Kidney	Inflammation	None	None	None	None	None	None
Kidney	Necrosis	None	None	None	None	None	None
Kidney	Injury	None	None	None	None	None	None
Intestine	Cilia	None	None	None	None	None	None
Intestine	Hypertrophy	None	None	None	None	None	None
Intestine	Hyperplasia	None	None	None	None	None	None
Intestine	Inflammation	None	None	None	None	None	None
Intestine	Necrosis	None	None	None	None	None	None
Intestine	Injury	None	None	None	None	None	None
Spleen	Hypertrophy	None	None	None	None	None	None
Spleen	Hyperplasia	None	None	None	None	None	None
Spleen	Inflammation	None	None	None	None	None	None
Spleen	Necrosis	None	None	None	None	None	None
Spleen	Injury	None	None	None	None	None	None
Heart	Hypertrophy	None	None	None	None	None	None
Heart	Hyperplasia	None	None	None	None	None	None
Heart	Inflammation	None	None	None	None	None	None
Heart	Necrosis	None	None	None	None	None	None
Heart	Injury	None	None	None	None	None	None

AEMOL₀₊ contained Gendox® 1.25 mg/l of water, AEMOL₀ contained 0 ml of moringa extract/l of water, AEMOL₃₀ contained 30 ml of moringa extract/l of water, AEMOL₆₀ contained 60 ml of moringa extract/l of water, AEMOL₉₀ contained 90 ml of moringa extract/l of water, AEMOL₁₂₀ contained 120 ml of moringa extract/l of water

The growth performance results in this study is in agreement with the results reported by Portugaliza and Fernandez (2012) which indicated that AEMOL inclusion levels resulted in lower feed and water intake at the starter phase which is also consistent with less water intake in all AEMOL treated groups compare to control and AEMOL₀. The reduction in water and feed intake in all AEMOL treated groups compare to control and

AEMOL₀ may have translated to reduced growth performance as recorded in the present study. This is consistent with the findings of Portugaliza and Fernandez (2012). This may be due to the presence of antinutrient substance in the extract as reported by Ramchandra et al. (2019). Ramchandra et al. (2019) reported that chemical such as antinutrients substances present in the diet by themselves or their metabolic products arising in the system, reduce feed intake and thus, interfere with the feed utilization. The present results however, are contrast to the report of Oludoyi and Toye (2012) who reported a significant difference in bodyweight at week 4, between broiler chickens fed diet containing 0, 10 and > 15% MOLM, whereas no significant difference in body weight was observed between pullet groups.

The better final weight, weight gain and feed intake recorded AEMOL₆₀ than in the control group suggests that 60 ml of AEMOL might be an optimal dose of aqueous extract of *Moringa oleifera* for better broiler growth performance at finisher phase. This is in line with the reports of Kakengi et al. (2003) and Olugbemi et al. (2010) who showed that *Moringa oleifera* inclusion levels (AEMOL₆₀) resulted in an increased body weight gain and feed intake due to high protein content in it. On the contrary, birds on aqueous extract of 120 ml per litre of water had the lowest weight gain despite the high protein content in the extract, suggesting an inverse growth relationship- the higher the dose, the higher the antinutrient contents and less the growth possible.

The higher feed intake at the finisher phase compared to the starter phase might be an indication that the older the birds, has better capacity to manage antinutrient contents. The improved FCR of birds on control could be as a result of the low feed intake recorded by the birds on this treatment group.

The results of sensory properties of broiler meat for the different treatments showed significant difference (appearance, flavour, tenderness, juiciness and general acceptance) among the experimental meat samples. No definite trend was in all the parameters assessed. Aqueous extract of *Moringa oleifera* leaf inclusion levels up to 90 ml/l were similar in the appearance, flavour, tenderness and general acceptability to control and recorded least flavour for AEMOL₁₂₀ treated group suggesting that AEMOL inclusion levels up to 90 ml/l can be used to replace growth promoters in terms of sensory attributes. Additionally, this might mean that poor flavour and tenderness of the meat are produced at inclusion levels above 90 ml/l. The present result is inconsistent with those of Safa et al. (2012) who reported that flavour and juiciness were not significantly influenced by *Moringa oleifera* leaf meal on broiler chickens.

The results of the histological parameters of tissue samples from the liver, lung, kidney, intestine, spleen, and heart of the broiler chickens did not show any adverse effects of administering aqueous extract of *Moringa oleifera* leaf to the broiler birds.

Conclusion

The results of this study showed that aqueous extract of *Moringa oleifera* leaf inclusion levels up to 60 ml/l can be used to replace antibiotic growth promoter without compromising the advantages of antibiotic growth promoter. Since it is easily available and can be source cheaply, the use may improve cost effectiveness, reduction in feed consumption with improved growth performance. It is recommended that other methods of extraction could be used to see if higher inclusion level will result in better performance.

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