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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Effect of Supplementation of *Moringa oleifera* Leaf Meal in Broiler Chicken Feed

D.W. Gakuya[1], P.N. Mbugua[2], B. Kavoi[3] and S.G. Kiama[3]
[1]Department of Clinical Studies, Faculty of Veterinary Medicine,
University of Nairobi, P.O. Box 29053 00625, Kangemi, Nairobi, Kenya
[2]Department of Animal Production, Faculty of Veterinary Medicine,
University of Nairobi, P.O. Box 29053 00625, Kangemi, Nairobi, Kenya
[3]Department of Veterinary Anatomy and Physiology, Faculty of Veterinary Medicine,
University of Nairobi, P.O. Box 30197 00100, Nairobi, Kenya

Abstract: The purpose of this study was to evaluate the effect of supplementing *Moringa oleifera* leaf meal (MOLM) at different levels in broiler chicken. Broiler starter and finisher diets were formulated using raw materials obtained from local feed manufacturers. MOLM was first analyzed for crude protein and then added to diets at levels of 0% (T1), 7.5% (T2), 7.5% (T3) (without Methionine and lysine), 15 (T4) and 30% (T5). Two hundred (200) day old broiler chicks were randomly allocated into the 5 treatment groups with 4 replicates of 10 birds each and the diets introduced. The feed intake, feed conversion ratio (FCR), weight gain, lipid profile, abdominal fat pad and feed digestibility were determined. The MOLM crude protein level was 23.33%. The weight gain was significantly different between the various diets with the highest weight gain being in T1 at 1464 and the lowest in diet T5 at 500. MOLM supplementation at levels above 7.5% decreased the feed intake and dry matter digestibility. The abdominal fat pad (AFP) was significantly higher in T1 compared to T2, T4 and T5. The males had a significantly high levels of High density lipids (HDL) than females in T2, T3 and T4 ($p<0.05$). The yellow colour of the carcass increased with the increased levels of MOLM. It was concluded that *Moringa oleifera* leaf meal (MOLM) was well tolerated and can only be included in the feed to levels of up to 7.5% as higher levels affected weight gain, feed intake and digestibility. Further studies on the yellowing of the carcass, its quality and acceptability by consumers is needed.

Key words: *Moringa oleifera* leaf meal, broiler chicken, feed intake, weight gain, abdominal fat pad, feed digestibility

INTRODUCTION

The poultry production in Kenya is constrained by inadequate supply of good quality feed and escalating costs. This is due to poor availability and expensive raw materials especially the proteins. The competition of humans and livestock for the same products further worsens the situation and therefore the need for sourcing for other available low cost materials that would substitute the raw materials already in the market especially the soybean and fishmeal.

Moringa oleifera is the best known of 14 species of Moringa tree (family Moringaceae). It is a fast-growing, drought-resistant tree native to sub-Himalayan tracts of northern India, Pakistan, Bangladesh and Afghanistan. It is now growing worldwide in the tropics and subtropics (Fahey *et al*., 2001). Its leaves and pods have been reported to be of great nutritional value and yield many vitamins and minerals. The leaves and the young green pods can be eaten like other vegetables.

Moringa has for long been consumed by humans and all its parts are edible. The tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Calcium, Iron, Vitamin C and carotenoids suitable for utilization where undernourishment is a major concern especially in the developing world (Fuglie, 1999). According to Price (1985), *Moringa oleifera* leaves would be of great use in treating malnutrition, in pregnant women and nursing women. The leaves of Moringa have also been reported to be rich in protein, carotene, iron and ascorbic acid while the pods are rich in amino acids lysine (CSIR, 1962). These excellent nutritional characteristics would make suitable as forage for feeding animals (Nuhu, 2010).

Analysis by Makkar and Becker (1996) on samples of extracted and unextracted Moringa leaves used as a component of animal feed reported a crude protein values of 43.5 and 25.1%, respectively. Therefore Moringa in both of these forms would be a good source of protein for livestock. Similarly Gupta *et al*. (1989) reported values for crude protein, crude lipids and ash to be 26.4, 6.5 and 12%, respectively. *Moringa oleifera* leaves were also reported to contain crude protein 27.51%, crude fibre 19.25%, crude fat 2.2.3%, Ash

Corresponding Author: D.W. Gakuya, Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi, P.O. Box 29053 00625 Kangemi, Nairobi, Kenya

7.13%, Moisture content 76.53%, carbohydrate 43.88% and calorific value of 305.62% (Oduro *et al*., 2008). They concluded that *Moringa oleifera* leaves could contribute to the nutrient requirements of humans and should be recommended in Ghana.

Nuhu (2010) reported values of Crude protein, Ether extract, Crude fibre, Ash and Nitrogen free extract to be 29.55, 2.2.3, 19.5 and 7.13%, respectively. The phosphorus and calcium levels were 0.33 and 8.64 mg, respectively. Variation in all these values by different authors would be due to agro-climatic conditions and maturity of the plant during the harvest. Although the levels of crude protein levels differs largely between difference authors, the values reported are relatively high and therefore *Moringa oleifera* would be a suitable supplement for animals feed.

Experimental work on the nutritive value of *Moringa oleifera* was carried out on weaner rabbits by Nuhu (2010). The study involved use of Moringa leaf meal (MOLM) to determine it's effect on nutrient digestibility, growth, carcass characteristics and haematological and biochemical indices of weaner rabbits. Using 5 treatments groups at various diets formulated to contain 0% (control), 5, 10, 15 and 20% of MOLM, the daily feed intake and feed conversion rate did not differ between dietary treatments. The average daily weight gain was higher in rabbits on the MOLM based diets compared to those on control diets ($p<0.05$). The carcass characteristics and blood parameters did not vary between different treatment groups. It was therefore concluded that MOLM could be used as partial or total replacement of Soybean meal without any adverse effects on the productive performance and blood indices of weaner rabbits.

Ly *et al*. (2001) evaluated the in vitro nitrogen digestibility of several tropical leaves which would potentially be used as pig feed using pepsin/pancreatin. *Moringa oleifera* had the highest in vitro Nitrogen digestibility of 79.2% compared with the other 12 tropical leaves.

Sanchez *et al*. (2005) evaluated the effect of feeding different levels of foliage from *Moringa oleifera* Lam to dairy cows on intake, digestibility, milk production and milk composition. Supplementation with Moringa increased ($p<0.05$) DM intake from 8.5 to 10.2 and 11.0 kg DM and milk production from 3.1 to 4.9 and 5.1 kg per day at 0, 2 and 3 kg DM of Moringa supplementation, respectively. There was no significant different between diets on the milk fat, total solids, crude protein, organoleptic characteristics smell, taste and colour. Moringa supplemented diets increased digestibility coefficient ($p<0.05$). It was concluded that Moringa inclusion as a protein supplement to low quality diets improved DM intake and digestibility of the diets and increased milk production without any effects on milk quality.

Other studies by Ashong and Brown (2011), evaluated the safety and nutritional efficacy of Moringa leaf meal on White-leghorn type chicks starting on day 7. Experimental diets were formulated to contain 0% (control), 10, 20 and 30% Moringa leaf powder. There were no signs of abnormal behaviour and or toxicity and mortality during the 5 weeks experimental period. The control group had a higher feed intake ($p<0.05$) with a corresponding higher weight gain ($p<0.0001$) compared with other treatment groups. The control group had significantly higher levels of cholesterol, triglyceride and uric acid. The authors suggested that though the incorporation of Moringa leaf may reduce intake and rate of gain, the ingredient is not toxic to growing poultry and the effect on blood lipid profile may be useful to human nutritionist.

Studies by Makkar and Becker (1996), on the nutrient and antiquality factors in different morphological parts of the *Moringa oleifera* tree concluded that leaves of *Moringa oleifera* and the residue obtained after recovery of oil and coagulants can be a good source of protein for animal feeds. They estimated that 87% of the total crude protein in the leaves was in the form of true protein and the leaves had negligible amounts of tannins. Trypsin and amylase inhibitors, lectins, cyanogenetic glucosides and glucosinates were not detected. About 64% of the total crude protein present in the leaves was found to be degradable after 24 h in the rumen.

The effect of inclusion of *Moringa oleifera* leaf meal (MOLM) in cassava chip based diet on laying birds was evaluated by Olugbemi *et al*. (2010). Using diets comprised of cassava chips (CC) and MOLM combination at various percentage and assigned to treatment groups (0% CC, 0% MOLM, 20% CC, 0% MOLM, 20% CC, 5% MOLM, 20% CC, 10% MOLM), the inclusion of MOLM had no influence on feed intake, feed conversion ratio and laying percentage. Feed cost per kilogram, feed cost per kilogram egg produced declined with inclusion of MOLM. Acceptability of cooked eggs was highest in the 10% MOLM group.

The effect of *Moringa oleifera* on growth performance and health status of young post-weaning rabbits was evaluated by Djakalia *et al*. (2011). Three different feeding supplements (Moringa supplement (3%), mixed (Moringa 1.5%, Standard 1.5%) and standard (3%) were used. The performance of the three types of feeding formulation was measured on post-weaning rabbits. The best results were obtained with Moringa supplement in terms of rabbit weight average and growth rate. The Moringa supplement also had the apparent faecal digestibility at 85% compared with the mixed and standard feeding formulation which had 80 and 81%, respectively.

There is therefore a need to evaluate the potential of *Moringa oleifera* as a feed supplement in poultry production in Kenya.

MATERIALS AND METHODS

Acquisition of raw materials and formulation of diets: The dried *Moringa oleifera* Lam leaf material was sourced from a farmer in Mtito- Andei division, Kibwezi district in Makueni county and ground using a commercial grinding mill into a fine powder. Ground maize, omena, soya bean, wheat pollard, limestone, cattle salt, broiler premixes, methionine and lysine were purchased from reliable feed manufacturers and all materials delivered to the department of Animal production. The proximate analysis and determination of the levels of calcium and phosphorus were was done on *Moringa oleifera leaf meal* (MOLM) before the feed formulation. The broiler starter and later broiler finisher diets were formulated using the raw materials and MOLM incorporated at 0% (T1), 7.5% (T2), 7.5% without methionine and lysine (T 3), 15% (T 4) and 30% (T5). These diets were later used for the 5 treatment groups with 4 replicates of 10 birds each.

Setting of the broiler house: The broiler house was thoroughly cleaned and disinfected prior to placement of the day old chicks and 20 cages to accommodate 10 birds each were brought into the house and the feeders, drinkers and infrared bulbs for heating set. Charcoal jikos were also set to provide extra heat during the night. Wood shavings were also placed on the floor of the cages. Prior to procurement of the birds, the cages were randomly allocated with labels of the various replicates of the treatment groups.

Experimental broiler chicken and their management: Two hundred and fifty day old broiler chicks were procured from the hatcheries of Kenchic LTD, Kenya and brought to the department of Animal production, University of Nairobi poultry unit and put on the cages. The day chicks were fed on commercial broiler starter for 2 days and water provided *ad libitum* prior to sexing. Ten (5 male and 5 females) chicks were allocated to each of the replicate and weighed before placing them on the appropriate cages. The experimental diets were introduced on day 3 and the chicks were vaccinated appropriately.

Management of the experimental diets and data collection: Each of the 4 replicates of the treatment group (T1, T2, T3, T4 and T5) had it's feed and bucket weighed and the chicks fed *ad libitum*. The amount consumed was determined by weighing the bucket and feed before and after consumption when the bucket had to be refilled with the feed. This was continued through out the experiment. The weight of the chicks were also determined for the whole replicate once a week till the end of the experiment. The experimental diets both the starter and finisher for the five treatment groups were analyzed using proximate analysis. The data collected was stored in Microsoft excel at the end of every week and feed intake, Feed conversion ratio(FCR) and weight gain calculated. The experiment was ended on day 38 of the experiment and all replicates of the treatment group were weighed.

Abdominal fat pad (AFP), Lipid profiles and nutrient digestibility studies: A male and a female birds from each of the 20 replicates were sacrificed. The AFP of these birds was removed, weighed and their percentage to the body weight determined. Blood samples were collected from the wing vein of one male and female from each of the 20 replicates for analysis of total cholesterol, triglycerides, High and low density lipids. Two birds (male and female) were selected from every replicate and were placed at their individual cage for digestibility studies. Five hundred grams of the respective treatment broiler finisher diet was offered to the birds and the remaining feed at the end of the day recorded. The daily faecal output was also recorded and a weighed faecal sample collected for proximate analysis.

Data analysis: All the data was entered and stored using MS Excel and later managed and analyzed using GenStat for windows 15th edition (Payne *et al*., 2007).

RESULTS

The proximate analysis showed the MOLM had a Crude protein of 23.33%. In all the treatments groups there was no sign of toxicity or mortality reported in the course of the experiment. The average body weight per bird was at the end of the experiment was 1512, 1386, 1183, 882 and 550 g for treatments T1, T2, T3, T4 and T5, respectively and was significantly different between these treatment groups ($p<0.05$) (Table 1). Diet T1 produced birds with significantly high weight (1512 g) than the rest of the diets with the lowest weight in diet T5 (550 g). The weight gain was also significantly different between the various diets with the highest weight gain being in T1 (1464) and the lowest in diet T5 (500). However there was no significant difference in feed intake between T1 (MOLM 0%), T2 (MOLM 7.5%) and T3 (MOLM 7.5%) ($p<0.05$). The two diets (T4 and T5) were significant different in feed intake with the rest of the groups (T1, T2 and T3). Chicken fed on diet T3 (7.5% MOLM and without methionine and lysine) had a significantly lower body weight and weight gain compared with those fed on diet T2 (7.5% MOLM and with methionine and lysine).

The feed conversion ratio (FCR) was lowest on T1 at 2.49 and highest at T5 at 5.43. However there was no significant difference in FCR of T1, T2 and T3 implying that MOLM at levels within 7.5% had minimal influence on FCR. The FCR of T5 was difference with all the other treatment groups and again this proved the negative effect of high levels of MOLM.

Table 1: Average body weight, weight gain, feed intake and feed conversion ratio

Parameter	T1	T2	T3	T4	T5	LSD
Body weight, g/bird	1512	1386	1188	882	550	104.6
Weight gain	1464	1336	1139	834	500	106.1
Feed intake g/bird	3638	3845	3483	2719	2708	643.2
FCR	2.49	2.88	3.04	3.27	5.43	0.617

Table 2: Dry matter, crude protein, crude fibre and NFE digestibility (%)

Parameter	T1	T2	T3	T4	T5	LSD
Dry matter	74.0	66.9	71.1	61.1	53.7	16.06
Crude fibre	20.4	32.9	35.0	20.5	21.6	20.08
Crude protein	69.1	54.1	64.5	54.5	50.7	19.42
NFE	80.6	78.8	81.3	72.4	67.7	11.30

Table: 3: Effect of diet on plasma lipids

Parameter	T1	T2	T3	T4	T5	LSD
HDL	1.63	1.87	1.97	2.11	1.71	0.416
LDL	0.87	0.67	0.86	0.98	0.88	0.420
TC	2.77	2.73	2.80	3.27	2.79	0.546
Total glycerides	1.34	0.93	1.29	0.94	0.95	0.461

Table 4: Effect of sex on plasma lipids

	-------- T1 ---------		--------- T2 ---------		--------- T3 ---------		--------- T4 ---------		--------- T5 ---------		
	M	F	M	F	M	F	M	F	M	F	LSD
HDL	1.70	1.57	2.01	1.74	1.98	1.62	2.26	1.96	1.83	1.60	0.27
LDL	0.83	0.92	0.64	0.71	0.83	0.87	1.10	0.85	0.94	0.82	0.09
TC	2.90	2.64	2.86	2.60	3.06	2.53	3.56	3.0	2.83	2.74	0.12
Total Glycerides	1.45	1.24	1.1	0.77	1.23	1.35	0.99	0.9	0.78	1.13	0.292

The difference in dry matter digestibility of the diets T1, T2, T3 and T4 was not significant($p<0.05$) but diet T5 had significantly lower dry matter digestibility at 53.7% which was significantly different from diets T1, T2 and T3. This implies that MOLM inclusion upto 15% did not affect dry matter digestibility and it is only on high levels (30%) that there was a negative effect (Table 2).

There was no significant difference in crude fibre digestibility although T2 and T3 had a higher crude fibre digestibility than the rest of the treatment. Similarly there was no significant difference on the crude protein digestibility between groups though T1 had the highest at 69.1% and T5 the least at 50.7%. There was also no significant difference in Nitrogen free extract (NFE) digestibility of T1, T2, T3 and T4 (Table 2).

The abdominal fat pad (AFP) of the birds expressed as percentage of body weight was significantly higher in diet T1 compared to T2, T4 and T5 but it had no difference with T3. Diets of T4 and T5 had the lowest AFP and were significantly lower than the rest of the diets ($p<0.05$). On the effect of sex on the abdominal fat pat, it was only in diet T1 and T4 where the males had significantly higher AFP than females. There was no significant difference of the AFP of males and females in the rest of the group.

The levels of High density lipids (HDL) were significantly higher in diet T4 than diet TRT1 but there was no significant difference with other groups. There was no significant difference between the various diets on the levels of Low density lipids (LDL), Total cholesterol (TC) and total glycerides (TG) (Table 3). On the effect of sex on the levels of HDL, the males had a significantly high levels than females in T2, T3 and T4 ($p<0.05$). The males also had higher levels in T1 and T5 though there were not significant. Therefore, male broiler birds had a higher HDL than females. The males in diets (T4 and T5) had a significantly higher LDL than females but the females in T1, T2 and T3 had higher levels of LDL though not significantly different (Table 4). The males had significant high levels of TC than females in all diets except T5. The levels of TC in males of diet T2 and T5 were significantly higher than females.

The colour of the carcass was more yellowish with the increase of the levels of MOLM. This yellowing in T2, T3, T4 and T5 was distinct compared with T1 which had no MOLM.

DISCUSSION

The level of crude protein in the current study was slightly lower than that reported by Nuhu (2010), Oduro *et al.* (2008), Gupta *et al.* (1989) and Makker and Becker (1996) who reported levels of 29.55, 27.51, 26.4 and 25.1%, respectively. The levels of crude protein may be influenced by the stage of leaf harvest and the agro-climatic conditions of the area. This may be verified by harvesting the leaves at an earlier stage and compare with the above results.

The MOLM was safe at the levels that was used. This concurred with some other authors who did not report any adverse effects (Ashong and Brown, 2011; Djakalia *et al.*, 2011; Nuhu, 2010).

The weight gain of the birds decreased with increase of MOLM levels in the diet. Therefore the inclusion of MOLM had an negative effect on the weight gain of the birds. This was also reported by Ashong and Brown (2011) where the control diet produced a higher weight gain compared to diets with MOLM on white leghorn type chicken. The feed intake of diets T4 and T5 were significantly lower than the rest but there was no difference between T1, T2 and T3 which implied that *Moringa oleifera* meal inclusion in levels up to 7.5% has no effect in feed intake. This partly concurs with studies done by Nuhu (2010) who reported that MOLM had no effect on feed intake at various diets formulated with MOLM in weaner rabbits. However in the current studies diets with 15 and 30% MOLM inclusion had a negative effect on feed intake. The increase in MOLM levels in the diet had no effect also on the digestibility of crude fibre, crude protein and NFE. This concurs with studies by Nuhu (2010) on rabbits who reported high levels of digestibility with increased MOLM inclusion.

The abdominal fat pad (AFP) of the chicken in diets of T4 and T5 was the lowest and were significantly lower than the rest of the diets ($p<0.05$). This implied that high levels of MOLM (above 7.5%) lowered the abdominal fat pad. The various diets had no significant difference on the levels of low density lipids (LDL), total cholesterol (TC) and total glycerides (TG). Therefore MOLM had no significant influence on lipid profiles of the broiler chicken. This was contrary to the report on the effect of MOLM on White-leghorn bird where high levels of MOLM significantly decreased levels of TC and TG (Ashong and Brown, 2011).

The males in the current studies having significant high levels of TC than females in all diets except T5 and concurs with those also reported by Bowes *et al*. (1989) when comparing serum biochemical profiles of male and female broilers.

The increase in the yellow color with the increase of the levels of MOLM may be attributed to high levels of carotenoids in the MOLM (CSIR, 1962) which may influence the color.

It is concluded that MOLM is well tolerated by the chickens. However, as per the current studies, it can only be included in the feed to levels of up to 7.5% as higher levels affected weight gain, feed intake and dry matter digestibility. Therefore farmers can include MOLM up to 7.5% to replace soybean meal in their broiler diets as chicken were able to attain a weight of 1386 g by day 38. The inclusion of MOLM also had no significant influence on lipid profiles of the broiler chicken. However, the increased levels decreased the abdominal fat pad. The exclusion of methionine and lysine in diet T3 had significant effect on the performance of the birds and it seems that MOLM was not able to provide sufficient amount of these two amino acids. The yellowing of the carcass needs to be further studied together with it's quality and the consumer's acceptability.

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