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POSSIBILITIES OF USING MORINGA (*Moringa oleifera*) LEAF MEAL AS A PARTIAL SUBSTITUTE FOR FISHMEAL IN BROILER CHICKENS DIETS

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ABSTRACT: *A six-week feeding trial involving 180 2-week old Cobb broiler chicks was conducted to assess the effects of partial replacement of fishmeal with Moringa (Moringa oleifera) leaf meal on broiler chickens. The birds were randomly assigned in equal numbers in a Completely Randomized Design (CRD) to four dietary treatments containing 0, 5, 10, and 15% Moringa leaf meal (MLM). Each treatment was replicated three times giving 15 birds per replicate. Feed and water were supplied ad libitum. The parameters measured were feed intake, initial weight, final weight, weight gain, feed conversion efficiency, carcass traits, hematology, serum biochemistry and meat quality. Final weight, weight gain, feed conversion efficiency significantly (p<0.05) declined with increasing level of MLM. None of the carcass traits measured was significantly affected by addition of MLM. Mean Corpuscular Hemoglobin (MCH) was the only hematological parameter that showed significance (P<0.05) difference in treatment groups. Triglycerides, Low Density Lipoprotein (LDL) and Very Low Density Lipoprotein (VLDL) differed significantly (P<0.05). Also incorporation of MLM significantly (P<0.05) affected the moisture, crude protein and crude fat of the meat of experimental birds. Cost benefit analysis showed that incorporation of MLM resulted in reduced feed cost. However, the net revenue from birds fed diets containing MLM reduced as a result of poor weight gain. Based on the data obtained in this study it is concluded that Moringa oleifera leaf meal when partially used to replace fishmeal may hamper growth rate of broiler chickens. Nonetheless, addition of MLM does not adversely affect mortality, carcass traits and blood variables.*

Key words: *Moringa, Performance, Hematology, Serum biochemistry and Meat quality.*

ORIGINAL ARTICLE

INTRODUCTION

Feed costs amount to a considerable proportion of production cost in any intensive livestock production system (Ekenyem, 2001). It has been reported that, feed cost represents up to 60-80% of the total cost of broiler production (Teguia and Beynen, 2005). Fishmeal, a conventional feed resource, has been used as the source of animal protein in diets of poultry in many countries including Ghana due to unavailability of cheaper alternative protein sources. With the present trend of rising prices of feedstuffs, considerable attention has been placed on the search for non-conventional feedstuffs (Esmail, 2002).

The protein from leaves may be fed to poultry in the form of leaf protein concentrate (Farinu et al. 1992). For instance, leaf meals made from shrubs have been useful to small-scale farmers (WAC, 2006). Various leaf meals have been used in poultry diets, including those of leucaena (Udedibie and Igwe, 1989), Amaranthus (Frages et al., 1993), centrosema (Nworgu, 2004) and cassava (Ogbnna and Oredein, 1998). One such non-conventional feedstuff, which could be of value for poultry feeding, is the leaves of moringa.

Moringa (*Moringa oleifera*) is a rapidly-growing tree which was used by the ancient Romans, Greeks and Egyptians as animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), green manure (from leaves), gum (from tree trunks), honey (flower nectar), medicine (all plant parts), pulp (wood), rope (bark) and water purification (powdered seeds) (Fuglie, 1999). It is now widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree and is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands. All parts of the Moringa tree are edible and have long been consumed by humans. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible

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protein, Ca, Fe, and carotenoids suitable for utilization in many developing regions of the world where undernourishment is a major concern (Oduro et al., 2008). Results of analyses by Oduro et al. (2008) revealed that moringa leaf meal contains 76.53, 27.51, 19.25, 7.13, 2.23, and 43.38% of Dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extract. A large number of reports on the nutritional qualities of Moringa now exist in literature (Fuglie, 2000). Because of the high protein content of the moringa leaf meal, it can be used to partially substitute fishmeal in poultry diets.

This experiment was therefore conducted to determine the effects of moringa leaf meal as a partial replacement for fishmeal on growth performance, carcass characteristics, hematology, serum biochemical parameters and meat quality of broiler chickens.

MATERIALS AND METHODS

Experimental diets and Preparation of Moringa leaves

Moringa *(Moringa oleifera)* leaves were harvested from an orchard near the College of Agriculture, University of Education, Winneba, Mampong Campus. The cut branches were spread out on a concrete floor and allowed to dry for a period of 3-4 days under room temperature. After drying, the leaves were separated from the twigs. They were then milled in a hammer mill to obtain the leaf meal (MLM).

Chemical Analysis of Moringa leaf meal and Experimental Diets

Samples of the MLM were subjected to proximate analysis according to AOAC (1990) methods (Table 3). The proximate composition of each experimental diet was also determined as above. Four iso-nitrogenous and iso-caloric experimental broiler diets were formulated and designated as MLM 0%, MLM 5%, MLM 10% and MLM 15% (Tables 1 and 2).

Experimental Design and Statistical Analysis

One hundred and eighty (180) Cobb broiler chicks procured at day-old from Darko Farms and Company, Kumasi, were initially brooded together for two weeks. At two weeks they were divided into four treatment groups with three replicate per each treatment, giving 15 birds per replicate in a Completely Randomized Design (CRD). Feed and water were provided *ad libitum* and all required managerial practices were the same for each treatment group. Daily feed intake and individual bird weights were recorded before and at the end of the experimental period. Daily weight gains and feed conversion efficiency were calculated. The data were analyzed using Statistical Analysis System (SAS, 1999). Multiple Range test was used to separate significant treatment means. Significance was accepted at 0.5 level probability.

Table 1 - Percentage Composition of Broiler Starter Diets

Ingredients	Level of dietary MLM (%)			
	MLM_0	MLM_5	MLM_{10}	MLM_{15}
Maize	58.00	58.00	58.00	58.00
Fish Meal (64% CP)	10.00	10.00	7.00	7.00
Fish Meal (52% CP)	7.00	2.00	2.00	2.00
Moringa leaf meal	0.00	5.00	10.00	15.00
Soybean meal	10.50	10.50	10.50	5.50
Wheat bran	12.00	12.00	10.00	10.00
Oyster shell	1.00	1.00	1.00	1.00
Vit/mineral premix	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Di-calcium phosphate	0.50	0.50	0.50	0.50
Proximate analysis % DM				
Crude protein	20..92	20..07	20.37	20.63
Crude fibre	3.33	4.23	4.77	5.64
Ether extract	4.24	3.89	3.64	3.68
Ash	12.33	13.54	13.86	14.09
NFE	59.18	58.27	57.36	55.96
Calculated composition (%)				
Calcium	1.04	0.98	1.02	1.14
Available phosphorus	0.70	0.60	0.54	0.53
Lysine	1.38	1.19	1.02	0.86
Methionine	0.44	0.37	0.31	0.28
ME (kcal/kg)	2750.00	2722.00	2708.00	2730.00

*Composition of vitamin/mineral premix per kg: Vitamin E, 25mg; Vitamin A, 6250 IU; Vitamin D3, 1250 IU; Vitamin K3, 25mg; Vitamin B1, 25mg; Vitamin B2, 60mg; Vitamin B6, 40mg; Vitamin B12, 2mg; Elemental calcium, 25mg; Elemental phosphorus, 9mg; Elemental magnesium, 300mg; Iron, 400mg; Selenium 1.0mg, Iodine 20mg, Copper 60mg, Magnesium 100mg, cobalt 10mg, Zink, 150mg; Sodium Chloride, 1.5mg; Choline Chloride, 500mg; Live Lactobaccillus spore, 0.2 million cfu; Niacin, 40mg; Folic Acid, 10mg; d-Biotin, 5mcg.

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Table 2 - Percentage Composition of Broiler Finisher Diets

Ingredients	Level of dietary MLM (%)			
	MLM_0	MLM_5	MLM_{10}	MLM_{15}
Maize	60.00	60.00	60.00	60.00
Fish Meal (64% CP)	6.00	6.00	6.00	6.00
Fish Meal (52% CP)	6.00	4.00	4.00	4.00
Moringa leaf meal	0.00	5.00	10.00	15.00
Soybean meal	13.00	10.00	5.00	2.00
Wheat bran	12.00	12.00	10.00	10.00
Oyster shell	1.00	1.00	1.00	1.00
Vit/mineral premix	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Di-calcium phosphate	1.00	1.00	1.00	1.00
Proximate analysis % DM				
Crude protein	18.73	18.59	18.06	18.88
Crude fibre	3.11	4.00	4.68	5.58
Ether extract	3.89	3.78	3.73	3.80
Ash	13.24	14.38	14.54	14.97
NFE	59.03	59.25	58.99	56.77
Calculated composition (%)				
Calcium	1.02	1.08	1.18	1.30
Available phosphorus	0.64	0.59	0.55	0.55
Lysine	1.22	1.04	0.87	0.77
Methionine	0.36	0.32	0.29	0.29
ME (kcal/kg)	2749.00	2767.00	2698.00	2709.00

*Composition of vitamin/mineral premix per kg: Vitamin E, 25mg; Vitamin A, 6250 IU; Vitamin D3, 1250 IU; Vitamin K3, 25mg; Vitamin B1, 25mg; Vitamin B2, 60mg; Vitamin B6, 40mg; Vitamin B12, 2mg; Elemental calcium, 25mg; Elemental phosphorus, 9mg; Elemental magnesium, 300mg; Iron, 400mg; Selenium 1.0mg, Iodine 20mg, Copper 60mg, Magnesium 100mg, cobalt 10mg, Zink, 150mg; Sodium Chloride, 1.5mg; Choline Chloride, 500mg; Live Lactobaccillus spore, 0.2 million cfu; Niacin, 40mg; Folic Acid, 10mg; d-Biotin, 5mcg.

Hematology and Serum Biochemistry Analysis

Blood samples were obtained from two birds per replicate making a total of six per treatment at the eighth week by inserting a new sterile needle into the wing vein of the birds and extracting 2 mls of blood which was placed inside sterile test tubes containing Ethylene Diamine Tetra Acetic Acid (EDTA). The blood samples were shaken to mix with the EDTA in order to prevent coagulation. The samples were then analyzed for Red Blood Cells (RBC), Packed Cell Volume (PCV), Hemoglobin (Hb) and White Blood Cells (WBC) using the Abbott Diagnostics Cell Dyn 3500 (Abbott Diagnostics, Abbott Park, IL) automated hematology analyzer. Again, blood samples were obtained from each bird by the same procedure mentioned above and drawn into vacuumed capillary tubes to determine the blood cholesterol, triglyceride, High-density Lipoprotein (HDL), Low-density Lipoprotein (LDL) levels, coronary risk, total protein and glucose. After coagulation, blood samples were centrifuged and then serum was collected for analysis. Serum biochemistry was determined by using Cobas integral 400 plus chemistry analyzer manufactured by Roche Diagnostics Ltd., Switzerland.

Carcass Evaluation and Chemical Analysis of Meat Yield

At the end of the experiment, two birds were randomly selected from each replicate. They were weighed and killed. The birds were killed by severing the carotic arteries. The birds were bled and immersed in hot water for 5 minutes to loosen feathers. The defeathered carcass was weighed. After dressing, the following weights were taken: carcass weight, dressed weight, gizzard, liver, heart, neck, shanks, and intestine. The crude protein, crude fat and ash composition of thigh meat was also determined using the methods of AOAC (1990).

RESULTS AND DISCUSSION

Results of proximate analysis of moringa leaves are presented in Table 3. The summarized results of performance of birds are also presented in Table 4. The final body weight (FBW), mean body weight gain, feed conversion efficiency declined significantly ($P<0.05$) with the dietary inclusion of MLM. Olugbemi et al. (2010) also reported a decline in final weight and weight gain with increasing level in diet when they included moringa leaf meal in cassava based diets. 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. But the effect of inclusion of moringa leaf meal on feed conversion efficiency (FCE) recorded in their study was different from what was observed

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in this work. In their study, FCE was highest for birds fed diets containing 750g/100kg moringa leaf meal and declined as the proportion of it in the diet decreased. Ash et al. (1992) have observed that inclusion of leaf meals in broiler diets above 5-10% resulted in depressed performance as was observed in this study. The health condition of experimental birds observed during the experimental period did not seem to have been affected by inclusion of MLM in diets. Du et al. (2007) reported that dietary supplementation of *M. oleifera* may increase immune ability of broilers. Apart from Mean Corpuscular Hemoglobin (MCH), all the other hematological indices were not significantly affected, indicating that the diets were nutritionally adequate to meet the nutrient needs of the birds. Birds fed 10 and 15% MLM-based diets rather recorded the lowest MCH whiles their counterparts on control and 5% MLM-based diets recorded the highest. Yellow coloration of body parts such as shanks and beak was observed. This could be attributed to the presence of xanthophylls and carotenoid pigments in MLM.

Table 3 - Proximate Composition of MLM (%)

Proximate fraction	%
Dry Matter	92.21
Crude protein	25.56
Crude fibre	16.45
Ash	7.41
Ether extract	3.33
Nitrogen free extract	47.25

Table 4 - Effect of MLM on Performance of Broiler Chickens (mean ± standard error)

Variable	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Mean Initial Body Weight (g)	260±0.00	260±0.00	260±0.00	260±0.00
Mean Final Body Weight (g)	2173± 23.76 [a]	1860± 1.00 [a]	1880± 43.00 [a]	1460± 90.00 [b]
Mean Total Body Weight Gain (g)	1913±37.12[a]	1600±1.00[a]	1620±50.33[a]	1200±94.52 [b]
Mean Daily Weight Gain	46.33±0.67[a]	39.33±2.67[b]	39.66±1.33[b]	29.27±2.27[c]
Mean Feed Intake (g)	125.43±0.97	137.53±7.72	124.50±0.76	125.70±4.43
FCE (Feed/Gain)	2.67±0.07[a]	3.53±0.12 [b]	3.17±0.07 [b]	4.33±0.18 [c]
Mortality (%)(GH₵)	0.00±0.00	2.22±2.22	0.00±0.00	2.22±2.23
Feed cost/kg diet (GH₵)	1.08	1.05	0.89	0.86
Feed cost/bird (GH₵)	5.46	5.88	5.04	5.46
Price/bird at 8 weeks (wt/kg) (GH₵)	6.00	6.00	6.00	6.00
Value/ bird (GH₵)	13.04	11.16	11.28	8.76
Net revenue/bird (GH₵)	7.04	5.16	6.24	3.30

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean; NOTE: US$ 1.0 = GH₵ 1.5

Table 5 - Effect of MLM Meal on Organ Weights of Broiler Chickens (mean ± standard error)

Variable	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Dressed Weight (g)	1444.00±23.67	1455.00±35.00	1433.00±9.00	1376.00±48.67
Dressing Percentage (%)	81.17±1.40	79.70±0.85	80.03±0.90	81.80±0.48
Carcass weight (g)	1179.33±19.67	1825.67±12.33	1791.67±29.33	1684.33±77.67
Liver	81.33±5.33	85.00±9.00	94.00±5.00	91.67±3.33
Kidney	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00
Heart	7.67±0.67	10.00±1.00	8.67±0.67	9.33±0.33
Full crop	11.00±0.00	11.67±2.67	12.33±1.67	11.00±0.00
Empty crop	9.67±0.67	9.67±0.66	11.67±1.33	10.33±0.33
Full proventriculus	9.33±0.33	9.33±0.33	9.33±0.67	8.66±0.67
Empty proventriculus	9.33±0.33	8.67±0.67	8.67±0.33	8.33±0.33
Full gizzard	54.00±0.00	57.67±0.33	60.67±7.33	55.33±1.33
Empty gizzard	40.00±0.00	39.67±0.33	40.33±3.67	39.67±1.33
Small intestine:				
Full	126.00±6.00	137.00±10.00	137.00±13.67	120.67±13.67
Empty	69.33±1.67	68.67±1.00	68.67±1.33	70.00±1.00

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

Table 6 - Effect of MLM Meal on Meat Quality (mean ± standard error)

Variable	Level of dietary MLM Meal (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Moisture	74.67±0.003[a]	30.90±0.003[b]	72.36± 0.003[c]	68.06±0.003[d]
Crude Protein	77.66±0.33[a]	70.06±0.03[b]	70.06±0.03[b]	62.13±0.03[c]
Crude Fat	22.53±0.3[a]	31.53±0.03[b]	30.50±0.003[c]	34.50±0.003[d]

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

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Triglycerides, VLDL and LDL values in blood serum of broilers were significantly different in treatment groups (P<0.05), however, total cholesterol, HDL-Cholesterol, coronary risk, total protein and glucose values were not found to be significantly (P<0.05) different (Table 9). A negative relationship between cholesterol and triglyceride values was also observed. The triglycerides and VLDL values of the groups fed with 5% MLM were the lowest. The cholesterol values of the group fed the control diets were the highest. In other studies, animals fed diets rich in cholesterol or saturated fat had elevated carcass cholesterol and blood cholesterol levels (Blanch and Grashorn, 1995). On the other hand, several researchers (Oayzdog˘an et al. 1996; Bachorik et al. 1991) have shown that low HDL and high LDL are values associated with atheroschlorosis.

None of the parameters measured for carcass characteristic (Table 5) was affected significantly (P>0.05) by inclusion of MLM. Incorporation of Moringa leaf meal in the diets however affected meat quality significantly (P<0.05). The moisture, crude protein and fat of the meats analyzed were significantly (P<0.05) affected by the dietary treatments (Table 6). The fat tended to increase as the level of MLM increased in the diets. Consumption of high levels of fat has been associated with high incidence of coronary heart diseases in humans (A.D.A.M., 2005). WHO (1990) recommended a reduced dietary fat intake. As the moisture content of the meat decreased, the fat content appeared to increase. Other researches on this subject support the negative relationship between carcass moisture and fat content (Mendes et al., 1995). Protein levels in meat reduced with increasing levels of MLM. The results of economic analysis (Table 4) indicated that the cost of feed reduced with increasing levels of MLM in the diets. Onibi et al. (2008) also reported a reduction in the cost of feed consumed at higher inclusion of leaf meals. However, the net revenue from birds dropped as the level of MLM in the diets increased. This could be attributed to the depressed weight gain recorded for birds fed these diets.

Table 7 - Effect of MLM on Blood Variables (mean ± standard error)

Parameter	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
WBC ($x10^3/\mu L$)	12.87±0.02	12.52±0.03	12.65±0.02	12.76±0.54
RBC ($x10^6/\mu L$)	3.06±1.00	3.18±0.18	3.08±0.17	3.43±0.17
HGB (g/dL)	14.16±0.43	14.60±0.80	13.73±0.97	14.83±0.97
HCT (%)	36.30±1.10	37.10±2.20	35.13±0.73	37.93±1.87
MCV (fL)	123.60±2.6	124.09±2.09	123.88±1.92	124.43±2.00
MCH (pg)	46.30±0.10[a]	45.86±0.13[a]	44.07±0.67[b]	43.17±0.73[b]
MCHC (g/dL)	39.03±0.03	39.33±0.17	38.70±0.30	39.33±0.67
LYM (%)	73.73±2.03	41.43±20.72	49.53±24.77	68.33±0.33
GRAN	5.17±0.83	2.87±2.87	3.33±1.67	7.87±0.07
MID	21.10±1.20	8.07±8.07	13.8±0.90	23.80±0.40
RDW	10.8±0.20	9.90±0.30	11.10±0.70	11.27±0.47

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

Table 8 - Effect of MLM on Blood Variables (mean ± standard error)

Parameter	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Total cholesterol (mmol/L)	3.04±0.19	2.73±0.44	2.52±0.27	2.49±0.17
Triglyceride (mmol/L)	1.14±0.14[a]	0.51±0.02[b]	1.20±0.17[a]	1.17±0.32[a]
HDL-Cholesterol (mmol/L)	2.40±0.10	2.04±0.32	1.92±0.30	1.83±0.33
LDL	0.13±0.03[a]	0.43±0.13[b]	0.03±0.03[a]	0.13±0.03[a]
Coronary Risk	1.30±0.00	1.30±0.00	1.33±0.07	1.33±0.07
VLDL	0.53±0.03[a]	0.20±0.00[b]	0.50±0.07[a]	0.53±0.17[a]
Total protein (g/L)	33.76±1.57	30.30±3.30	30.40±1.2	32.00±1.2
Glucose (mmol/L)	13.28±1.19	12.36±0.12	11.61±0.23	11.91±2.55

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

CONCLUSION

From this study it can be concluded that *Moringa oleifera* when partially used to replace fishmeal may hamper growth rate of broiler chickens. However, inclusion of MLM at the levels used in this study may not have any adverse effect on health and carcass quality. Again it was observed that inclusion of MLM in diets led to a reduction in feed cost. The net revenue recorded for birds on diets containing MLM however reduced due to depressed weight gain.

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