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Growth Performance, Blood Profile and Economic Efficiency of Layer Chicks Fed Diets Containing Graded Levels of Moringa Leaf Meal at Pre-Laying Phase

Samuel Kwafo
M Phil. Student, Department of Animal Science Education,
University of Education, Winneba, Ghana
James Kwame Kagya-Agyemang
Professor, Department of Animal Science Education
University of Education, Winneba, Ghana
Serekye Yaw Annor
Professor, Department of Animal Science Education
University of Education, Winneba, Ghana
Fritz Ramseyer Karikari Bonsu
Senior Lecturer, Department of Animal Science Education
University of Education, Winneba, Ghana

Abstract:
A study was carried out to assess the effects of Moringa oleifera leaf meal (MOLM) inclusion in diets on the growth performance, blood profile and economic efficiency of layer chicks. Three hundred (300) one-day old layer chicks of ISA Brown breed were allocated to five dietary treatments and three replicates in a complete randomize design. Five different diets containing 0%, 3%, 6%, 9% and 12% MOLM were designated as treatments 1, 2, 3, 4 and 5. Treatment 1 was the control diet. Data collected were subjected to analysis of variance with the aid of SAS (2008). The results obtained showed that feed intake at the starter phase was lower (P<0.05) in the test diets. The final body weight, live weight gain and feed conversion ratio were better (P<0.05) in the test diets than the control at the starter phase. At the pullet phase feed intake was similar (P>0.05) among the dietary treatments. The final body weight, weight gain and feed conversion ratio were better (P<0.05) in the test diets than the control. Apart from haemoglobin, the haematological characteristics measured namely red blood cells, white blood cells, lymphocytes, granulocytes, platelets and MIDcells (monocytes, eosinophils, basophils and other precursor white cells) showed significant increased (P<0.05) responses in the test diets. Total serum protein, albumin level, cholesterol level and globulin showed significant increased (P<0.05) responses to the test diets. The mean cost of feed per kilogram and the mean cost of feed per kilogram gain of body weight decreased with increasing inclusion of MOLM. The study indicated that the inclusion of MOLM in the diet of layer chicks (from starter through pullet phase) had positive impact on growth and better economic efficiency in layer chicks.

Keywords: *Moringa oleifera, starter, pullet, growth performance, haematological, biochemical, leaf meal*

1. Introduction

The poultry industry is key to fighting poverty, improving food security and providing livelihood in many parts of the world (Attoh-Kotoku et al., 2010) but the growth and expansion of the poultry enterprise is being hampered by high cost of feed and occasional shortage of feed ingredients. This situation has arisen largely due to inadequate supply of feed ingredients of protein origin such as fishmeal (Dei et al., 2010). In poultry, feed is estimated to represent 65%-75% of the variable cost of production (MoFA, 2010). Therefore, changes in commodity prices for poultry feed have direct effect on the cost of production. Chicken compete with humans over food ingredients particularly those of protein origin like fishmeal so attention is currently focused on exploitation of lesser known or non-conventional feed resources (Attoh-Kotoku et al., 2010).

Moringa oleifera is known to contain high concentrations of proteins, carbohydrates, vitamins and minerals and all the essential amino acids (Makkar et al., 1997;Kakangi et al., 2007) making it more suitable for feeding monogastric animals like chicken, pigs and rabbits. It has the ability in boosting immune systems of birds and increases their resistance to diseases (Kakangi et al., 2007). In spite of the nutritive and medicinal value of *Moringa oleifera*, there is scanty information regarding its utilization in layer chicks. The study was carried out to determine the optimum level at which *Moringa oleifera* leaf meal could be incorporated in the diets of layer chicks to improve their growth performance, blood profile and economic efficiency at pre-laying phase.

2. Materials and Methods

2.1. Location and Duration of Experiment

The experiment was carried out at the Poultry Section of the Animal Science Farm of the Department of Animal Science Education, University of Education, Winneba, Mampong-Ashanti, Ghana. The experiment took twenty weeks.

2.2. Experimental Birds and Design

Three hundred (300) one-day-old layer chicks of ISA Brown breed were obtained from Jerusalem Farms in Accra, Ghana and used for the experiment. The study began with birds with similar initial body weights which is a good requirement for a Complete Randomized Design. The experimental diets were formulated as shown in Tables 1 and 2. Each of the five treatments was allocated sixty (60) birds with 20 birds in each of the three replicates. The Complete Randomized Design (CRD) was used. The dietary treatments were iso-nitrogenous and iso-caloric. The diets formulated were subjected to proximate analysis using the procedure of the (AOAC, 2000).

Ingredients	T_1 (0% MOLM)	T_2 (3% MOLM)	T_3 (6% MOLM)	T_4 (9% MOLM)	T_5 (12% MOLM)
Maize grain	50	50	50	50	50
Wheat Bran	15	13.5	12	10.5	9
Soya Bean	10	8.5	7	5.5	4
MOLM	0	3	6	9	12
Anchovey	11	11	11	11	11
Tuna fishmeal	7	7	7	7	7
Vitamin Premix	0.5	0.5	0.5	0.5	0.5
Oyster shells	5.5	5.5	5.5	5.5	5.5
Common salt	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate	0.5	0.5	0.5	0.5	0.5

Table 1: Composition of Starter Diet

Ingredients	T_1 (0% MOLM)	T_2 (3% MOLM)	T_3 (6% MOLM)	T_4 (9% MOLM)	T_5 (12% MOLM)
Maize grain	54	54	54	54	54
Wheat Bran	16	14.5	13	11.5	10
Soya Bean	8	6.5	5	3.5	2
MOLM	0	3	6	9	12
Anchovey	6	6	6	6	6
Tuna fishmeal	8	8	8	8	8
Vitamin Premix	0.5	0.5	0.5	0.5	0.5
Oyster shells	6.5	6.5	6.5	6.5	6.5
Common salt	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate	0.5	0.5	0.5	0.5	0.5

Table 2: Composition of Grower Diet

2.3. Housing and Feeding of Chicks

The chicks were housed in cages with concrete floors and covered with wood shavings. Each cage measuring 3.11 m x 1.1m housed twenty (20) birds. The birds were fed starter diet from the first day to the end of the eighth week and grower diet from the beginning of the ninth week to the end of the twentieth week. Feed and water was supplied to chicks *ad-libitum* throughout the experimental period. The feed was offered daily and the leftover weighed each day before feeding.

2.4. Parameters Measured

Feed intake and body live weight gain were measured using electronic salter balance. Feed conversion ratio was calculated as feed intake divided by weight gain. The number of birds that died during the experimental period was recorded as mortality. The Sysmex Haematological Auto-Analyser was used for the haematological analysis. Total protein was determined using the Biuret method, while blood albumin was determined using the Bromo Cresol Green (BCG) method. Total cholesterol was estimated using the CHOP-PAP method and globulin content was determined by subtracting albumin level from the total protein level. The mean cost per kilogram feed was calculated and multiplied by the mean feed conversion ratio to obtain the cost per kilogram gain of live body weight (cost/kg gain).

2.5. Analysis of Data

The data was analyzed with SAS (2008) using the Analysis of Variance (ANOVA) technique. The means were separated by the Least Significant Difference (LSD) test at 5% (P>0.05) significant level.

3. Results and Discussion

3.1. Proximate Composition of Moringa Leaf Meal

The proximate composition of moringa leaf meal is shown in Table 3

Analysis	Value (%)
Crude protein	28.50
Crude fibre	13.05
Ether extract	5.20
Ash content	9.43
Dry matter	90.21
ME (MJ/kg DM)	8.43

Table 3: Proximate Composition of Moringa Leaf Meal

The result of proximate analysis revealed the presence of high crude protein, appreciable amounts of crude fibre, ash, ether extract and metabolizble energy. These values were similar to values obtained in previous studies (Makkar et al., 1997; Kakangi et al., 2007; Abou-Flezz et al., 2011; Yameogo et al., 2011 & Ogbe et al., 2012). The slight variations in the chemical composition of the moringa leaves could be attributed to age of plant, soil fertility and processing method used. The presence of these nutrients indicated that MOLM could be utilized as a nutritionally valuable ingredient for poultry.

3.2. Proximate Composition of the Experimental Diets

The proximate composition of the experimental diets is shown in Table 4.

	T_1 (0%MOLM)	T_2 (3%MOLM)	T_3 (6%MOLM)	T_4 (9%MOLM)	T_5 (12%MOLM)
Starter diet					
CP (%)	20.78	20.32	20.45	20.16	20.14
EE (fat) (%)	3.18	3.09	3.06	3.01	3.00
CF (%)	2.03	2.15	2.19	2.21	2.26
ASH (%)	10.32	10.49	11.04	12.11	13.07
DM (%)	92.97	92.46	92.22	91.88	91.26
ME (MJ/kg DM)	11.44	11.24	11.02	10.81	10.59
Pullet diet					
CP (%)	15.07	14.42	14.25	14.28	14. 34
EE (fat) (%)	2.68	2.63	2.59	2.51	2.42
CF (%)	2.13	2.36	2.49	2.51	2.66
ASH (%)	11.12	11.19	12.14	12.11	13.17
DM (%)	92.77	91.36	91.02	90.88	90.21
ME(MJ/kg DM)	11.87	11.77	11.44	11.23	11.01

Table 4: Proximate Composition of Experimental Diets
CP= Crude Protein, EE= Ether Extract, CF= Crude Fibre, ASH = Ash Content,
DM = Dry Matter, ME= Metabolizable Energy

The crude protein levels of the formulated diets (Table 4) were within the recommended levels for layers (NRC, 1994). These values fell within 20-21% for starters and 14- 15% for pullets (NRC, 1994). Ether extract showed a decreasing trend with increasing MOLM, which is in agreement with the findings of Kakengi et al. (2007). The decreasing ether extract levels could be attributed to the decreased inclusion levels of soya bean in the diets as soya bean is known to have a high fat content (Gadzirayi et al., 2012). Crude fibre and ash showed an increasing trend in the test diets which was in contrast with (Kakengi et al., 2007) but in collaboration with (Gadzirayi et al., 2012). The crude fibre values in this study were below the recommended maximum levels at 6% for layer chicks (Gietema, 2006; Kakengi et al., 2007) and thus the feed had better crude fibre levels, because the higher the crude fibre content, the poorer the diet for monogastrics like poultry birds. Crude fibre levels in the test diets increased because of the slightly high fibre content of MOLM.
The energy value of the control diet (Table 4) was slightly higher than that of the test diets. This is because the energy content of MOLM (Table 3) is lower than that of wheat bran and soya bean, which were decreasing as MOLM level was increasing in the diet formulation (NRC, 1994).

3.3. Growth performance of Starter Chicks

The effect of MOLM on growth performance of starter chicks is shown in Table 5.

	T1 (0% MOLM)	T2 (3% MOLM)	T3 (6% MOLM)	T4 (9% MOLM)	T5 (12% MOLM)	L.S.D	Standard error
MIBW (g/bird)	40.30	40.20	40.13	40.40	40.20	0.70	0.21
MFI (g/bird)	1580.22[b]	1546.82[d]	1550.43[cd]	1614.63[a]	1560.93[c]	11.73	3.60
MFBW (g/bird)	482.63[c]	514.07[ab]	510.27[b]	516.67[ab]	518.40[a]	7.96	2.44
MBWG (g/bird)	442.33[c]	473.87[ab]	470.13[b]	476.27[ab]	478.20[a]	7.75	2.38
FCR	3.57[a]	3.26[d]	3.30[c]	3.39[b]	3.26[d]	0.04	0.01
Mortality (%)	8.33	13.33	11.67	10.00	11.67	6.20	1.90

Table 5: Effect of MOLM on Growth Performance of Starter Chickens (0-8 Weeks)
Means within Rows with Different Superscripts Are Significantly Different (P<0.05)

MIBW= Mean Initial Body Weight, MFI= Mean Feed Intake, MFBW= Mean Final Body Weight, MBWG= Mean Body Weight Gain, FCR= Feed Conversion Ratio MOLM = *Moringa oleifera* leaf meal

The variability in feed intake (Table 5) by birds on test diets could be attributed to the digestive system adjusting to digesting fibre in the MOLM. The amount of feed intake indicated that MOLM was palatable and preferred by chicks (Abou-Flezz et al., 2011; Kakengi et al., 2007).

The observed improved final body weight and body weight gain (P < 0.05) by chicks on MOLM (Table 5) might be due to the presence of high pepsin soluble nitrogen, acid detergents soluble protein and low anti–nutritional factors in MOLM (Makkar et al., 1997). This suggested that protein in MOLM was readily available to the chicks (Abou-Flezz et al., 2011). Chicks fed diets that contained the MOLM generally had a better efficiency (P<0.05) in converting feed to body weight which was in agreement with the findings of Melesse et al. (2011). The presence of vitamins in MOLM might have improved the efficiency of feed utilization of the chicks (Gietema, 2006). Mortality in the birds was not significant (P>0.05) and so cannot be attributed to the test diets.

3.4. Growth Performance of Pullet Chicks

The effect of MOLM on growth performance of pullet chickens is shown in Table 6.

	T1 (0% MOLM)	T2 (3% MOLM)	T3 (6% MOLM)	T4 (9% MOLM)	T5 (12% MOLM)	L.S.D	Standard error
MIBW (g/bird)	482.63[c]	514.07[ab]	510.27[b]	516.67[ab]	518.40[a]	7.96	2.44
MFI (g/bird)	2750.96	2786.87	2788.40	2910.72	2918.07	83.52	25.61
MFBW (g/bird)	1272.57[d]	1329.47[c]	1335.83[c]	1420.00[b]	1429.53[a]	8.05	2.47
MBWG (g/bird)	789.94[e]	815.40[d]	825.56[c]	903.33[b]	911.13[a]	6.32	1.94
FCR	3.48[a]	3.42[ab]	3.38[b]	3.22[c]	3.20[c]	0.10	0.03
Mortality (%)	10.90	8.47	11.23	9.27	13.40	14.00	4.29

Table 6: Effect of MOLM on Growth Performance of Pullet Chickens (9-20 Weeks)
Means within Rows with Different Superscripts Are Significantly Different (P<0.05)

MIBW= Mean Initial Body Weight, MFI= Mean Feed Intake, MFBW= Mean Final Body Weight, MBWG= Mean Body Weight Gain, FCR= Feed Conversion Ratio, MOLM = *Moringa oleifera* leaf meal

The initial body weights were different (P<0.05) because it was continuous from the starter phase. Unlike the starter phase, feed intake in the pullet phase was similar (P>0.05) and could be attributed to the developed digestive system of birds which led to the efficient digestion of MOLM. The observed increased body weight and weight gain by pullets on the test diets could be attributed to the presence of high pepsin soluble nitrogen, low levels of acid detergent insoluble protein and low anti–nutritional factor in MOLM (Makkar et al., 1997; Melesse et al., 2011). Also the protein in moringa leaf was readily available to chicks (Fuglie, 2001)]. The presence of methonine and other amino acids (Fuglie, 2001), in moringa leaf meal might have contributed to the observed better growth performance of chicks fed MOLM based diets compared to the control diet (Atuahene et al., 2010; Melesse et al., 2011).

All MOLM fed chicks showed better efficiency in converting feed to body tissues. It might be due to the presence of vitamins in MOLM diets which improved the efficiency of feed utilization and consequently increased body weight (Gietema, 2006).

Mortality in pullets was similar (P>0.05), and could not be attributed to the dietary treatments.

3.5. Haematological and Biochemical Characteristics

Table 7 shows the effect of MOLM on haematological and biochemical characteristics of layers.

	T_1 (0% MOLM)	T_2 (3% MOLM)	T_3 (6% MOLM)	T_4 (9% MOLM)	T_5 (12% MOLM)	L.S.D	Standard error
Haematological Characteristics							
White blood cells (k/μl)	82.77[e]	83.50[d]	85.50[c]	90.77[b]	93.53[a]	0.24	0.07
Red blood cells (M/μl)	2.31[c]	2.33[b]	2.35[a]	2.36[a]	2.37[a]	0.02	0.01
Lymphocytes (%L)	58.33[e]	63.63[d]	67.00[c]	72.77[b]	73.47[a]	0.34	0.10
Granulocytes (RM)	2.43[d]	2.53[cd]	2.67[c]	3.00[b]	3.50[a]	0.23	0.07
Haemoglobin (g/dl)	10.30	13.70	11.03	11.27	11.63	4.91	1.51
Platelets (k/μl)	4.00[c]	5.33[b]	6.00[a]	6.10[a]	6.20[a]	0.52	0.16
MID cells (%M)	13.47[e]	14.30[d]	14.47[c]	15.43[b]	16.20[a]	0.17	0.05
Biochemical Characteristics							
Total serum protein (g/dl/)	47.00[d]	47.43[d]	49.20[c]	50.20[b]	51.00[a]	0.69	0.21
Albumin level (g/dl)	18.00[d]	19.97[c]	21.13[b]	21.27[b]	23.10[a]	0.51	0.16
Cholesterol level (g/dl)	3.43[a]	3.20[a]	2.70[b]	2.57[b]	2.10[c]	0.29	0.09
Globulin (g/dl)	29.00[a]	27.46[e]	28.07[c]	28.93[b]	27.90[d]	0.29	0.09

Table 7: Effect of MOLM on Haematological and Biochemical Characteristics of Layer Chicks
Means within Rows with Different Superscripts Are Significantly Different (P<0.05)
MOLM = Moringa oleifera Leaf Meal
MID Cells = Monocytes, Eosinophils, Basophils and Other Precursor White Cells

The white blood cells count was higher for birds fed MOLM based diets and that was in agreement with the observation that MOLM could stimulate the immune system (Fuglie, 2001) resulting in higher number of white blood cells. The red blood cell levels increased in the blood of birds fed MOLM based diets than the control (0% MOLM) due to the presence of iron in moringa as previously reported by Ogbe et al. (2012). It could also be attributed to the fewer amounts of saponins since high amount of saponins might have had haemolytic activity against red blood cells in the body of birds (Ogbe et al., 2012).

The lymphocytes levels (Table 7) were above the normal range of 25- 40%L (Dein, 1984). This might be attributed to some amount of toxicity and infections introduced to the chicks (Lewis et al., 2002) from feeding on the litter (wood shavings), which gingered the production of high levels of lymphocytes to offer protection.

The blood haemoglobin levels were similar and therefore MOLM did not have appreciable effect on haemoglobin despite the presence of iron in it (Ogbe et al., 2012). Blood platelets and MID cells were increased with the inclusion of MOLM and this might partly be due to immune ability offered by MOLM (Fuglie, 2001).

Even though the lymphocytes and MID cells were higher than the reference range (25-40%L and 0-13%Mrespectively) and platelets were lower (reference range of 15-40k/μl) (Dein, 1984), they were not detrimental to the birds.

Total serum protein is an indication of the protein retained in the animal's body and it depends on the quantity and quality of dietary protein (Esonu et al., 2001). The serum protein levels recorded were below the normal levels of 60-80g/dl (Mitruka et al., 1977). Comparatively, birds on the test diets had higher serum protein than the control birds. This could be attributed to high dietary protein present in MOLM (Makkar et al., 1997) which is capable of being retained as serum protein.

Total serum cholesterol levels were low in MOLM based diets. This was consistent with the observation made by Ogbe et al. (2012). It could be attributed to the fact that, MOLM reduced the activity of the 3-enzyme-3-methylglutaryl CoA (HMG-CoA) reductase, a key enzyme in the liver, which is the regulatory enzyme in cholesterol synthesis (Crowell, 1999). In addition, MOLM might have enhanced bile acid synthesis and increased degradation of cholesterol to faecal bile acid and natural sterols and hence lowering serum cholesterol. Chithra and Leelamma, 1997; Crowell, 1999; Ogbe et al. (2012), reported that saponins (in excess) cause hypocholestrolaemia because it binds cholesterol, making it unavailable for absorption. Saponins levels in MOLM was very low (Makkar et al.,1997) hence cholesterol was made available for digestion and absorption in the MOLM based diets (Ogbe et al., 2012) and therefore registering low cholesterol level. This attribute is good for egg consumers who have health concerns on cholesterol intake into the body. There was high globulin concentration in chicks on the control diet as compared to those on test diets. This observation might be attributed to resistance of the chicks against different stress factors like varying ambient temperature that occurred within the raining season during the pullet stage (Gietema, 2006).

Although cholesterol and globulin levels obtained in the present study were lower than the reference ranges of 3.6-6.5g/dl and 31.0-34.5g/dl respectively (Mitruka et al., 1997), however no adverse effect was observed on the birds.

As blood represents a means of assessing clinical, nutritional and health status of animals, the results of the biochemical variables suggested that the MOLM based diets did not precipitate adverse effects on the health status of laying hens.

3.6. Economic Efficiency of using MOLM

Table 8 shows the effect of MOLM on the economics of production.

Treatment	Mean cost/kg feed (GH¢)	Mean FCR	Mean cost/kg gain (GH¢)
T_1(0% MOLM)	10.20	2.71	27.64
T_2(3% MOLM)	9.75	2.53	24.67
T_3(6% MOLM)	9.41	2.53	23.81
T_4(9% MOLM)	9.05	2.49	22.53
T_5(12% MOLM)	8.73	2.42	21.13

Table 8: Effect of MOLM on Economic Efficiency of Using MOLM
FCR= Feed Conversion Ratio MOLM = Moringa oleifera Leaf Meal

The cost benefit analysis shown in Table 8 indicated that the mean cost of feed per kilogram and the mean cost per kilogram gain of body weight decreased with increasing inclusion of MOLM. The cost of feeding chicks on MOLM based diets was lower than the cost of feeding chicks on the control diet.

Feed cost to grow the birds was lower in chicks fed the MOLM based diets and this was due to the lower price disparities of the *Moringa oleifera* leaf meal as compared to the other conventional feed ingredients. Therefore, the use of non-conventional feedstuffs reduced feed cost and this corroborates with the observation made by Melesse et al. (2011). Since feed cost accounted for about 65-75% of the total cost of production (MoFA, 2010), the utilization of inexpensive local feed materials like *Moringa oleifera* leaf meal could be of economic benefit to growth and egg production of layer chicks (Ayssiwede et al., 2010).

4. Conclusion

The result of this study shows that moringa leaf meal (MOLM) has appreciable nutrient composition especially protein which could be used as a feed ingredient for feeding layer chicks. There was no detrimental effect of MOLM on growth performance and blood profile of starter and pullet chicks. It was more economical to grow layer chicks at 12% inclusion level.

This study has shown that;

- MOLM at 12 % incorporation, had positive impact on mean final live body weight, body weight gain and feed conversion ratio of starter chicks.
- MOLM increased the mean final live body weight, body weight gain and feed conversion ratio at pullet phase at 12% level of incorporation.
- MOLM had no detrimental effect on blood profile of layer chickens.
- MOLM could increase economic benefit in layer chicken production.
- MOLM could be used as a feed ingredient for starter chicks and pullets.

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