Online Journal of Animal and Feed Research

Volume 2, Issue 2: 108-112 (2012)

ISSN 2228-7701

RESPONSE OF BROILER CHICKENS TO DIETS CONTAINING VARYING LEVELS OF LEUCAENA (*Leucaena leucocephala*) LEAF MEAL

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ORIGINAL ARTICLE

ABSTRACT: *A six-week experiment was conducted to assess the response of Cobb broiler chicks to diets containing varying levels (0%, 5%, 10% and 15%) of Leucaena leaf meal (LLM). The 4 dietary treatments were allotted to the birds in a completely randomized design. Each treatment consisted of three replicates, with fifteen birds per each replicate. The birds were fed experimental starter diets (14-28 d) and finisher diets (28-56 d). Feed and water were provided ad libitum. Final weight, growth rate and feed conversion ratio significantly (P<0.05) declined as the level of LLM in the diets increased. Dressed and carcass weights also reduced significantly (P<0.05) with increasing level of LLM in the diets. All organ characteristics except liver kidney were significantly (P<0.05) affected by dietary treatments. Haematological variables were also not affected (P<0.05). The total cholesterol and Low Density Lipoprotein of serum decreased (P<0.05) when LLM was included to the diets. Feed cost reduced when LLM was incorporated in the diets, but the net revenue declined as LLM in diet increased. In this study inclusion of LLM in diets for broiler chickens did not affect their health status, but rather depressed their growth.*

Key words: *Feed cost, haematology, Leucaena leaf meal, performance, serum biochemistry*

INTRODUCTION

The meat and eggs from poultry are estimated to contribute between 20 and 30% of the total animal protein supply in many developing countries (FAO, 2004), thus, filling the gap for animal protein needs of people. However, feed cost remains a major challenge for efficient poultry production in developing countries. It accounts for about 80% of the total cost of production (El Boushy and Van Der Poel, 2000). Ani *et al.* (2009) advocated that any attempt to increase poultry production needs to focus on the utilization of cheap and locally available ingredients.

A possible cheap source of protein that can be exploited for this purpose is the leaves of tropical legumes and browse plants (Agbede and Aletor, 2003). However, constraints to the utilization of leaf meals as protein sources include high fibre content and presence of anti-nutritional factors (Tewe, 1991). One plant of interest is *Leucaena leucocephala.*

It is a vigorous and drought-resistant leguminous tree whose high protein leaves has been widely used in ruminant animal feeds in the tropics (Nuttaporn and Naiyatat, 2009). Ayodeji (2005) recorded 25.1% crude protein in the fresh leaves of leucaena. Eniolorunda (2011) reported proximate composition of leucaena leaf meal to be 88.2% dry matter, 21.8% crude protein, 15.1% crude fibre, 3.1% ash, 8.6% ether extract, and 50.7% nitrogen free extract.

There is lack of information on the usefulness of Leucaena leaf meal in poultry diets. Therefore, the objective of this study was to determine the effects of incorporating different levels of LLM on the performance of broiler chickens.

MATERIALS AND METHODS

Experimental diets and preparation of leucaena leaf meal (LLM)

Fresh leaves of *Leucaena leucoceplala* were harvested from a year-old leucaena stands on the premises of the College of Agriculture, University of Education, Winneba, Mampong campus. The branches were cut and spread out on a clean concrete floor of well ventilated room for a period of 3-4 days until they became crispy. The leaves were separated from the twigs and milled in a hammer mill to obtain the leaf meal.

To cite this paper: Zanu HK, Mustapha M and Addo Nartey M. 2012.Response of broiler chickens to diets containing varying levels of Leucaena (*leucaena leucocephala*) leaf meal. *Online J. Anim. Feed Res.*, 2(2): 108-112.
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Chemical analysis of LLM and experimental diets

Samples of the LLM and experimental diets were subjected to proximate analysis using standard methods (AOAC, 1990) and results shown in Table 1.

Experimental design and statistical analysis

One hundred and eighty (180) day-old Cobb broiler chicks were procured from Darko Farms and Company, Kumasi. They were initially brooded for two weeks. At two weeks of age they were divided into four treatment groups with three replicate per each treatment, giving 15 birds per replicate in a Completely Randomized Design (CRD). The birds were allocated in such a way as to ensure that the average bird weight per replicate was around 260 g. 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. Daily weight gains and feed conversion efficiency were calculated. Economics of production were also calculated at the end of the study. The data were analyzed using the analysis of variance (ANOVA) technique and differences among means were separated by means of Duncan multiple range test. Statistical significance was determined at P=0.05.

Haematology and blood 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), Haemoglobin (Hb) and White Blood Cells (WBC) using the Abbott Diagnostics Cell Dyn 3500 (Abbott Diagnostics, Abbott Park, IL) automated haematology analyzer. Again, blood samples were obtained from each bird by the same procedure 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. Blood serum biochemistry was determined by using Cobas integral 400 plus chemistry analyzer (Roche Diagnostics Ltd., Switzerland).

Carcass evaluation and chemical analysis of thigh muscle

Two birds were randomly selected from each replicate at the end of the study. They were weighed and killed. The birds were killed by severing the carotic arteries. They 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. Proximate composition of thigh muscle was also determined using the procedure of AOAC (1990).

RESULTS AND DISCUSSION

Results of proximate analysis of leucaena leaf meal are presented in Table 1. It reveals that it is rich in protein (23.00%) and high in fiber (14.30%) and ash (11.20%). The crude protein content was higher than those (23.0% and 21.3%) obtained respectfully by Onibi et al. (2008) and Hussain et al. (1991). The final body weight, mean body weight gain and feed conversion efficiency declined significantly (P<0.05) as the level of LLM increased in the diets (Table 3).

Other studies involving chickens and laying hens show that, feed intake, live weight gain and egg production declined when *Leucaena leucocephala* leaf meal was included at 5 %, 20 % and 30 % of the diet (Scott et al., 1982). This poor performance may be attributed to the high fiber and the presence of anti-nutritional factors such as mimosine in leucaena leaves. High fiber diet exerts deleterious effects through depressed nutrient absorption as a result of extensive disruption of intestinal microvilli (Moharrery and Mohammed, 2005). Mimosine also affects thyroid function, leading to poor growth (Nuttaporn and Naiyatat, 2009). According to Natanman *et al.*, (1996), 5% inclusion rate of leucaena leaf meal is recommended for broilers since it gives higher feed conversion. This was however not the case in the present study.

Table 1 - Proximate Composition of LLM (%)

Proximate fraction	%
Moisture	8.65
Crude protein	23.44
Crude fibre	14.30
Ash	11.20
Ether extract	6.40
Nitrogen free extract	36.01

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Table 2 - Percentage Composition of Experimental Diets								
Items / Ingredient	Starter phase				Finisher phase			
	0% LLM	5% LLM	10% LLM	15% LLM	0% LLM	5% LLM	10% LLM	15% LLM
Maize	58	58	58	58	60	60	60	60
Fish Meal (64% CP)	10	10	7	7	6	6	6	6
Fish Meal (52% CP)	7	2	2	2	4	4	4	4
Leucaena leaf meal	0	5	10	15	0	5	10	15
Soybean meal	10.5	10.5	10.5	5.5	13	10	5	2
Wheat bran	12	12	10	10	12	12	10	10
Oyster shell	1	1	1	1	1	1	1	1
Vit/mineral premix	0.5	0.5	0.5	0.5	0	0	0	0.5
Salt	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5
Di-calcium phosphate	0.5	0.5	0.5	0.5	1	1	1	1
Proximate analysis (% DM)								
Moisture	8.63	8.00	8.54	8.48	8.45	8.06	8.19	8.33
Crude protein	20.32	20.01	20.18	20.09	17.73	17.15	17.01	17.10
Crude fibre	3.33	4.82	5.59	6.87	3.11	3.06	7.97	6.81
Ether extract	4.24	4.72	4.37	4.34	3.89	3.78	4.47	4.90
Ash	3.12	3.15	3.32	3.46	3.12	2.87	2.44	2.45
Nitrogen free extract	59.78	59.30	58.00	56.76	63.70	65.08	59.92	60.41
Calculated composition (%)								
ME (K cal/kg)	2605	2611	2601	2600	2880	2878	2878	2880
Calcium	1.04	1.54	1.02	1.13	1.02	0.95	0.47	0.95
Phosphorus	0.70	0.74	0.53	1.30	0.64	0.57	0.51	0.50
Lysine	1.38	1.19	1.02	0.86	1.22	1.04	0.91	2.35
Methionine	0.44	0.32	0.31	0.28	0.36	0.32	0.95	0.26

*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.

Table 3 - Effect of LLM Meal on Performance of Birds						
Variable	Level of dietary LLM (%)					
	LLM_0	LLM_5	LLM_{10}	LLM_{15}	P	SEM
Mean Initial Body Weight (g)	260.7	260.6	361.4	260.3	0.14	5.14
Mean Final Body Weight (g)	2236.7^{a}	1598.3^{b}	1380.0^{c}	1176.7^{cd}	0.00	90.98
Mean Total Body Weight Gain (g)	1983.3^{a}	1436.7^{b}	1118.3^{c}	915.0^{cd}	0.00	1211.30
Mean Daily Weight Gain (g)	47.3^{a}	34.2^{b}	26.6^{c}	21.8^{c}	0.00	2.85
Mean Feed Intake (g/day)	112.4^{a}	116.5^{a}	108.5^{ab}	97.5^{c}	0.00	2.31
FCE (Feed/Gain)	2.4^{a}	3.4^{b}	4.1^{bc}	4.5^{cd}	0.02	0.37
Mortality (%)	0.0^{a}	6.6^{b}	2.2^{a}	0.0^{a}	0.01	0.24
Feed cost/kg diet (GH₵)	1.1	1.1	0.9	0.9	-	-
Feed cost/bird (GH₵)	5.1	5.1	0.9	0.9	-	-
Price/bird at 8 weeks (wt/kg) (GH₵)	6.0	6.0	6.0	6.0	-	-
Value/ bird (GH₵)	13.4	9.6	8.3	7.1	-	-
Net revenue/bird (GH₵)	8.3	4.5	4.2	3.4	-	-

SEM = Standard error of mean; Treatment means with different superscripts within the same row are significantly different at p<0.05.

Table 4 - Effect of LLM Meal on Organ Weights of Broiler Chickens						
Variable	Level of dietary LLM (%)					
	LLM_0	LLM_5	LLM_{10}	LLM_{15}	P	SEM
Dressed Weight (g)	1481.3^{a}	1267.3^{a}	1189.0^{b}	838.0^{c}	0.04	-
Dressing Percentage (%)	88.9^{a}	81.3^{b}	78.6^{b}	81.6^{b}	0.02	2.90
Carcass weight (g)	1665.7^{a}	1555.3^{a}	1513.3^{a}	1080.0^{b}	0.01	119.64
Liver (g)	53.7^{a}	22.0^{b}	44.0^{ab}	26.0^{bc}	0.03	9.49
Kidney (g)	1.0	1.0	1.0	1.0	-	-
Heart (g)	8.7^{ab}	7.0^{b}	9.0^{ab}	5.7^{bc}	0.29	0.97
Full crop (g)	8.0^{a}	13.0^{b}	8.3^{a}	9.0^{a}	0.04	1.03
Empty crop (g)	8.0^{a}	10.3^{a}	8.3^{a}	7.7^{b}	0.10	1.00
Full proventriculus (g)	9.0^{a}	10.0^{b}	8.0^{c}	7.3^{d}	0.00	0.24
Empty proventriculus (g)	9.0^{a}	9.0^{b}	8.0^{c}	6.7^{d}	0.00	0.47
Full gizzard (g)	58.7^{a}	50.7^{ab}	52.3^{ab}	44.7^{b}	0.04	4.53
Empty gizzard (g)	45.7^{a}	35.7^{b}	39.3^{ab}	30.3^{bc}	0.03	4.09
Small intestine:						
Full (g)	105.3^{ab}	109.0^{a}	116.3^{a}	90.0^{ab}	0.05	7.80
Empty (g)	66.3^{a}	68.0^{a}	62.7^{a}	52.7^{b}	0.21	4.04

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

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The feed cost of raising broilers progressively decreased with increasing levels of LLM such that it was cheaper to raise them on LLM based diets than the control diet; but economic analysis showed decreasing returns with increasing dietary levels of LLM. This was so because of the poor growth performance of the birds fed the LLM. The LLM diets gave the lowest financial returns averaging 51.5% lower than the control diet.

All carcass and organ characteristics measured (Table 5), except kidney, were significantly influenced (P>0.05) by dietary treatments. The dressed weight tended to decrease with higher inclusion of leucaena leaf meal.

There was a significant (P<0.05) increase in the fat contents of the muscles with increasing levels of LLM in the diets. This suggests that LLM would promote fat deposition in broiler chickens. This finding is not good because consumption of high levels of fat has been associated with high incidence of coronary heart diseases in human. A reduced dietary fat intake is therefore recommended. It was observed that fat concentration in thigh muscle of birds has a negative correlation with the cholesterol contents in serum.

Table 5 - Effect of LLM Meal on Meat Quality

Variable	Level of dietary LLM (%)					
	LLM_0	LLM_5	LLM_{10}	LLM_{15}	P	SEM
Moisture	62.1^a	70.2^b	60.4^c	68.6^d	0.00	0.05
Protein	51.6^a	65.5^b	47.0^c	56.4^d	0.00	0.00
Fat	31.5^a	33.0^b	36.0^c	43.5^d	0.00	0.00

SEM = Standard error of mean; $^{a,b,c,d:}$ Treatment means with different superscripts within the same row are significantly different at p<0.05.

The results of haematological variables suggested that though sub-clinical effects (growth depression and less feed intake) were observed, the experimental diets did not precipitate detrimental effect on the health status of broiler chickens. All the values recorded compete favourably with normal ranges for broiler chicken (Table 6) as stated by Campbell et al. (2003). Hematological parameters are usually related to health status and are of diagnostic importance in clinical evaluation of the state of health. They are good indicators of physiological, pathological and nutritional status of an animal. Changes in haematological parameters have the potential of being used to elucidate the impact of nutritional factors in diet on animals. In this study, addition of LLM to the broiler diet was shown to reduce serum cholesterol concentration. Broiler chickens fed animal-based protein diet tend to have higher total plasma cholesterol than those fed plant-based protein (Ogboko, 2011). Most of the circulating cholesterol is carried in birds by high-density lipoprotein cholesterol and LDL (Zantop, 1997). A high blood level of total cholesterol is a major risk factor for heart disease, along with high levels of LDL. The higher the LDL level, the higher the risk.

Table 6 - Effect of LLM on Blood Variables

Variable	Level of dietary LLM (%)					
	LLM_0	LLM_5	LLM_{10}	LLM_{15}	P	SEM
WBC ($x10^3/\mu L$)	233.7	220.6	233.9	241.8	0.25	9.59
RBC ($x10^6/\mu L$)	2.4	2.1	2.4	2.7	0.29	0.27
HGB (g/dL)	9.4	8.2	9.3	10.1	0.33	90.97
HCT (%)	29.6	26.7	30.5	32.4	0.35	3.00
MCV (fL)	123.0	127.5	125.1	121.0	0.22	2.91
MCH (pg)	39.0	39.1	38.3	37.8	0.39	0.82
MCHC (g/dL)	31.7	30.7	30.3	31.2	0.23	0.23

SEM = Standard error of mean; $^{a,b,c,d:}$ Treatment means with different superscripts within the same row are significantly different at p<0.05.

Table 7 - Effect of LLM on Blood Variables

Variable	Level of dietary LLM (%)					
	LLM_0	LLM_5	LLM_{10}	LLM_{15}	P	SEM
Total cholesterol (mmol/L)	3.3^a	2.7^b	2.7^b	2.9^b	0.01	0.16
Triglyceride (mmol/L)	1.3	1.5	1.4	2.2	0.20	0.43
HDL-Cholesterol (mmol/L)	2.2	2.0	2.0	1.9	0.24	0.17
LDL	0.5^a	0.1^b	0.2^b	0.2^b	0.00	0.07
Coronary Risk	1.5	1.3	1.4	1.6	0.20	0.10
VLDL	0.6	0.7	0.6	1.0	0.21	0.21
Total protein (g/L)	39.3	36.8	33.2	31.1	0.28	4.17
Glucose (mmol/L)	11.5	12.8	12.6	11.7	0.76	2.07

SEM = Standard error of mean; $^{a,b,c,d:}$ Treatment means with different superscripts within the same row are significantly different at p<0.05.

CONCLUSION

Results of this study indicate that the inclusion of LLM in diets as low as 5% had adverse effects on the growth performance and economy of gain of broiler chickens.

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ACKNOWLEDGMENT

The authors wish to thank the Clinical Pathology Departments of the Okomfo Anokye Teaching Hospital, Kumasi and Ashanti Mampong District Hospital for respectively doing the serum and hematological analyses.

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