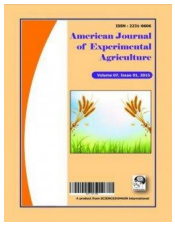

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Effect of Replacement of Soybean Meal with *Leucaena leucocephala* Leaf Meal on Performance, Haematology, Carcass Measures and Organ Weight in Broiler Chickens

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Authors' contributions

This work was carried out in collaboration between all authors. Author FOE wrote the protocol and the manuscript. Authors FOE, DEA and MA managed the field work and laboratory analysis of the study. Author FOE managed the literature search. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to determine the effect of replacing soybean meal (SBM) with *Leucaena leucocephala* leaf meal (LLM) in the diet of broiler chickens. One hundred and fifty one-day-old broiler chicks were allotted to five treatments, each with three replicates and ten birds per replicate in a completely randomized design. The experiment was carried out at the University Teaching and Research Farm, Federal University of Technology Akure. The feeding trial lasted for 8 weeks. The treatments were Diet 1 (control, without LLM replacement) and Diets 2, 3, 4, and 5 where soybean meal (SBM) was replaced by 25%, 50%, 75%, and 100% of LLM, respectively from 0-56 days of rearing. Substitution of SBM with LLM significantly ($P < 0.05$) influenced the performance of broilers

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from day 0-28, but not at 29-56 days. Body weight gain of 907 g was obtained in birds on Diet 3 (50% LLM), while the least value of 553 g was obtained for Diet 5 with 100% LLM. The diet containing 50% LLM had better FCR (2.66) than the other treatments. Substitution of SBM with LLM did not significantly influence the haematological parameters except Erythrocyte Sedimentation Rate (ESR) concentration, which was significantly ($P < 0.05$) affected. Organ weights were not affected by diet from 0-28 days but from 29-56 days, weights of organs were significantly ($P < 0.05$) reduced as the level of LLM in diet increased. Carcass parts were significantly ($P < 0.05$) reduced by dietary LLM at 0-28 and 29-56 days, except for the back, drumstick, neck, head and shank that were not affected by LLM. Results of the study showed that LLM could be used to supplement SBM up to 50% in the diets of broiler chickens to improve performance and without adverse effect on the birds.

Keywords: Leucaena leucocephala leaf meal; *soybean meal; performance; carcass; broilers.*

1. INTRODUCTION

Poultry meat is accepted world-wide. Poultry production in Nigeria is one of the most popular enterprises among the small and medium scale farmers. However, feeding constitutes 70–80% of the cost of poultry production [1,2]. Commercial feedstuff accounts for 60-85% of the cost of feeding [3-6] with protein ingredients constituting the bulk [4]. The prices of these ingredients have continued to soar making them uneconomical to use in poultry feeds [7]. The need to use unconventional feedstuffs for economical broiler production has become necessary. In order to ensure a sustainable and profitable supply of broiler meat, there is need to minimize the cost of feeds and maximize profit. The need to intensify the search for alternative or unconventional feedstuffs that can be substituted for the conventional and expensive ones is desirable [8]. It was therefore the objective of this study to determine the effect of supplementing soybean meal with *Leucaena leucocephala* leaf meal (LLM) on the growth, haematological parameters, carcass characteristics and organ weight of broiler chickens.

2. METHODOLOGY

Two hundred 1-day-old Abor Acre chicks were purchased from a local farm (Zarm Farms, Km 20, Offa, Kwara State, Nigeria) out of which 150 birds were used for the experiment. The feed ingredients were purchased from a local feed shop, while the Leucaena leaves were harvested from the location where the study was carried out. The leaves were immersed in hot water for 10 minutes. The water was drained and the leaves air–dried to ensure complete removal of moisture. The dried leaves were then milled using a hammer mill.

2.1 Experimental Diets and Birds

Five diets were formulated in which Leucaena leaf meal (LLM) replaced soybean meal (SBM) in the basal diet at 0, 25, 50, 75 and 100% 1, 2, 3, 4 and 5, respectively. The study was conducted in 2 phases, Starter (1-28 days) and Finisher (29-56) days. The birds were weighed using a sensitive digital BAT 1 balance. They were sexed and distributed into the 5 experimental diets with 3 replicates per treatment and 10 birds (5 males and 5 females at Starter phase) and 8 birds (4 males and 4 females at Finisher phase) per replicate. The birds were reared in an open-sided house, covered with wire mesh to allow optimum ventilation. They were kept on deep litter on concrete floor covered with wood shavings. The stocking density was one bird/0.1 m^2. The brooding temperature from day I to 28 was between 30-35ºC, which was reduced to about 28ºC at 29-56 days of age. The birds were exposed to 12 hours of light and 12 hours of night and a relative humidity of about 80%. The birds were fed *ad libitum*. The gross compositions of the experimental diets at Starter and Finisher phases are shown in Tables 1 and 2.

2.2 Sample Collection, Carcass and Organ Measures

Blood samples were collected from 3 chicks at 4 and 8 weeks from each pen through the jugular vein. The blood was treated with EDTA. The Packed Cell Volume (PCV) was estimated by spinning about 75 Fl of each blood sample in heparinized capillary tubes in a haematocrit micro centrifuge for 5 min while the total Red Blood Cell Count (RBC) was determined using normal saline as the diluting fluid. The Haemoglobin Concentration (HBC) was

estimated using cyanome-thaemoglobin method while the Mean Corpuscular Haemoglobin Concentration (MCHC), Mean Corpuscular Haemoglobin (MCH), the Mean Corpuscular Volume (MCV) and other variables were determined by standard procedure [9]. For Carcass measure 45 broilers were slaughtered each at 28 and 56 days. The birds were defeathered and weighed. The eviscerated weight was obtained by removal of the offal and internal organs after the defeathering. Carcass parts and organs were weighed and their weights expressed as per cent of live body weight.

2.3 Chemical and Statistical Analysis

The proximate composition was determined according to the method of AOAC, [10]. Data were analysed by ANOVA using the general linear model (GLM) procedures of SAS [11]. Means were separated using Duncan Multiple Range test.

3. RESULTS AND DISCUSSION

3.1 Performance Characteristics

The results of performance of the birds are shown in Table 3. Substitution of SBM with LLM significantly ($P<0.05$) reduced the performance of the birds at day 0-28 but not at day 29-56. This suggests that high inclusion level of LLM may not support growth performance of broilers at starter phase due to the presence of anti-nutritional factors such as mimosine in the LLM because essential anti-nutrients in LLM have been reported to be capable of retarding growth [12] and lowering the digestibility and absorption of dietary nutrients [13]. The FCR observed in all the treatments indicated that high level of inclusion of LLM significantly ($P<0.05$) affected the FCR. But it was reported [14] that 5% replacement of the CP of fishmeal by LLM or Sesbania leaf meal did not reduce the performance of broilers. Results of the present study corroborate those of [15] who fed 0, 5, 10 and 15% LLM in diets for Cobb broiler chicks. The authors reported that final weight, growth rate and FCR decrease with increase in dietary LLM. The dressed and carcass weights were also reduced. Similarly, [16] reported reduced weight of Anak 2000 broiler chicks fed either cassava leaf meal (CLM) or LLM at 30 or 60% replacement for SBM protein. The authors stated that CLM and LLM in a 50:50 combination could replace 9.55% of a SBM based diets fro broilers. However, 5% and 10% levels of LLM in diet were reported to be optimum for highest weight gain and feed intake, respectively in Vencobb broilers [17].

According to the author, feed efficiency was not affected by the diets. From the fore-going, LLM effect on broiler performance can be due to the specie of birds used, the processing methods or its use in combination with other feed ingredients, especially other plant proteins in the diet.

3.2 Organ Weight

The results of organ weights are shown in Table 4. Organ weights were significantly ($P<0.05$) lowered at the starter phase as LLM inclusion in diets increased. But at the finisher phase, there was no effect of dietary LLM on the weight of the organs. At the starter phase, the birds' organs are still developing and their weights would be negatively influenced by the toxic substances in the LLM. But as the birds grow and the organs develop, they are able to overcome the influence of the toxins in LLM hence the non-significant effect of dietary LLM on the weights of the organs in this phase. Results of the present study are similar to those earlier reported [15]. They reported that dietary level of LLM up to 15% had no effect on organ characteristics except the liver and kidney, which were significantly affected. It has also been reported [16] that carcass, organ and muscle characteristics were not affected by diets containing either CLM or LLM. The authors however reported that CLM and LLM diets caused more pigmentation in the birds than the control birds that received not CLM or LLM.

3.3 Haematological Indices

Supplementation of SBM with LLM did not significantly influence the haematological parameters except ESR concentration, which was significantly ($P<0.05$) affected at the finisher phase (Table 5). Haematological components of blood are valuable in monitoring feed toxicity especially with feed constituents that affect the composition of blood [18]. However, other workers [15] did not also find any effect of LLM inclusion on haematological variables in Anak 200 broilers. It has been similarly reported that LLM in diets up to 12% had no effect on haematology, glucose and mortality in broilers [19]. Leucaena contains mimosine, and since LLM substitution did not affect the haematological variables, it is therefore likely that the mimosine factor had no effect on those variables except ESR concentration.

Table 1. Gross composition of the starter diets (g/100 g dry matter)

Ingredients (%)	Diets				
	1	2	3	4	5
	Inclusion rate of LLM used to replace SBM				
	0%LLM	25% LLM	50% LLM	75% LLM	100% LLM
Maize	55.35	52.18	49.01	47.25	44.06
Wheat Offal	1.00	1.00	1.00	1.00	1.00
Soybean meal	15.00	11.16	7.50	3.75	0.00
Leucaena leaf meal(LLM)	0.00	6.08	12.16	18.24	24.32
Groundnut cake	15.00	15.00	15.00	15.00	15.00
Brewers' dry grain	5.00	5.00	5.00	5.00	5.00
Fish meal	5.00	5.00	5.00	5.00	5.00
Bone meal	1.50	1.50	1.50	1.50	1.50
Oyster shell	1.00	1.00	1.00	1.00	1.00
Broiler premix	0.25	0.25	0.25	0.25	0.25
Methionine – DL	0.25	0.25	0.30	0.33	0.35
L – Lysine	0.15	0.27	0.38	0.50	0.62
Salt	0.50	0.50	0.50	0.50	0.50
Vegetable oil	0.00	0.70	1.40	1.70	2.40
Total	100.0	100.0	100.0	100.0	100.0
Calculated nutrient content					
Crude protein (%)	23.95	23.65	23.36	23.03	22.74
ME (Kcal / kg)	2915	2878	2840	2802	2764
Calcium (%)	1.312	1.316	1.320	1.323	1.327
Available phosphorus	0.486	0.467	0.448	0.419	0.400
Lysine	1.221	1.221	1.211	1.208	1.207
Methionine	0.640	0.632	0.634	0.634	0.692

**D1 = Control Diet, D2 – D5 = Diet with LLM, LLM = Leucaena leucocephala leaf meal g/100g = %*

Table 2. Gross composition of the finisher diets (g/100 g dry matter)

Ingredients	Diets				
	1	2	3	4	5
	0 LLM	25%LLM	50%LLM	75% LLM	100%LLM
Maize	51	48.85	46.7	44.55	42.4
Wheat Offal	9	9	9	9	9
Soybean meal	14	10.5	7	3.5	0
Leucaena leaf meal	0	5.65	11.3	16.95	22.6
Groundnut cake	14	14	14	14	14
Brewers' dry grain	5	5	5	5	5
Bone meal	2.5	2.5	2.5	2.5	2.5
Limestone	1	1	1	1	1
Broiler premix	0.5	0.5	0.5	0.5	0.5
Methionine – DL	0.3	0.3	0.3	0.3	0.3
L – Lysine	0.2	0.2	0.2	0.2	0.2
Salt	0.5	0.5	0.5	0.5	0.5
Vegetable oil	2	2	2	2	2
Total	100.0	100.0	100.0	100.0	100.0
Calculated nutrient content					
Crude protein	21.73	21.52	21.30	21.06	20.81
M.E (Kcal / kg)	2967.65	2939.49	2911.99	2900.02	289368
Calciun	1.44	1.44	1.44	1.44	1.44
Available phosphorus	0.54	0.53	0.51	0.50	0.48
Lysine	1.01	1.02	1.01	1.01	1.00
Methionine	0.50	0.50	0.46	0.43	0.41

**ME = Energy (Kcal / kg), D1 = Control Diet, D2 – D5 = Diet with LLM, LLM = Leucaena leaf meal g/100g = %*

3.4 Carcass Characteristics

Results of carcass characteristics are presented in Table 6. Carcass parts were significantly (P<0.05) reduced by dietary LLM at starter and finisher phases except for the back, drumstick, neck, head and shank that were not significantly affected.

Table 3. Performance of broilers fed Leucaena leaf meal experimental diets

	Diets						
Phase/parameters	**0%LLM**	**25%LLM**	**50%LLM**	**75%LLM**	**100%LLM**	**SEM**	**P-value**
Day 0-28							
Feed intake, g/b	1404^{a}	1357^{a}	1280^{a}	1046^{eb}	853^{c}	61.4	<0.0004
Body weight gain, g/b	819^{a}	588^{b}	491^{c}	333^{d}	238^{e}	17.4	0.0001
Feed conversion ratio	1.72^{ed}	2.31^{d}	2.61^{cb}	3.12^{b}	3.58^{a}	0.11	<0.0001
Day 29-56							
Feed intake, g/b	2599	2568	2344	2098	2229	123.2	0.0687
Body weight gain, g/b	980	887	907	730	553	105.1	0.0975
Feed conversion ratio	2.67	2.92	2.66	3.16	4.05	0.35	0.0985

**a,b,c,d,e means along the same row with dissimilar superscripts differs significantly (P<0.05), LLM = Leucaena leucocephala leaf meal, SEM- Standard error of the; T1 – Control (without LLM), T2 –25% LLM, T3 – 50% LLM, T4 – 75% LLM, T5 – 100% LLM*

Table 4. Effect of Leucaena leaf meal substitution on organ weight (g/100 g live weight) in broiler chickens

	Diets						
Phase/parameters	**0%LLM**	**25%LLM**	**50%LLM**	**75%LLM**	**100%LLM**	**SEM**	**P-value**
Day 0-28 (n=30)							
Live weight	847.25^{a}	609.53^{cb}	611.43^{b}	450.03^{db}	391.67^{ed}	42.70	0.0002
Dress weight	750.45^{a}	547.08^{cb}	559.37^{b}	421.28^{db}	360.80^{ed}	37.10	0.0002
Eviscerated weight	626.30^{a}	432.83^{cb}	435.88^{b}	304.65^{db}	270.85^{ed}	32.95	0.0001
Liver	16.65^{a}	13.32^{ab}	13.85^{ab}	10.40^{b}	11.08^{cb}	0.95	0.0064
Kidney	4.97^{a}	3.58^{ab}	4.57^{ab}	2.98^{a}	2.72^{b}	0.49	0.0328
Heart	4.92^{a}	3.03^{ab}	3.40^{ab}	2.33^{b}	2.08^{cb}	0.51	0.0197
Pancreas	2.47	2.13	2.43	1.97	1.73	0.19	0.0886
Spleen	0.92^{a}	0.92^{a}	0.92^{a}	0.53^{b}	0.57^{ab}	0.08	0.0110
Gizzard	20.47^{a}	14.32^{b}	13.93^{cb}	13.40^{db}	10.28^{eb}	1.06	0.0007
Proventriculus	5.13^{a}	4.18^{ab}	3.55^{ab}	3.07^{b}	2.32^{eb}	0.43	0.0092
Day 29-56 (n=60)							
Live weight	1925^{a}	1821^{a}	1805^{a}	1646^{b}	1642^{b}	65.1	0.0484
Dress weight	1796^{a}	1688^{a}	1654^{a}	1463^{ab}	1479^{ac}	60.0	0.0109
Eviscerated weight	1504^{a}	1421^{a}	1408^{a}	1250^{ab}	1213^{ac}	48.8	0.0082
Liver	37.02	38.36	40.45	35.43	34.19	2.24	0.3674
Kidney	5.74	6.24	7.83	7.73	9.31	1.09	0.2295
Heart	7.23	8.53	7.82	6.97	6.96	0.50	0.1981
Lungs	10.98	12.26	9.97	9.14	9.29	0.79	0.0915
Pancreas	3.71	3.68	3.36	3.48	3.63	0.32	0.9283
Spleen	2.62	2.83	2.68	2.55	2.33	0.22	0.6442
Gizzard	32.20	30.90	35.05	29.95	32.58	1.74	0.3557
Proventriculus	7.93	9.66	8.18	7.04	7.26	0.59	0.0691

**a, b, c, d, e means along the same row with dissimilar superscripts differs significantly (p<0.05) g/100 g = %*

Table 5. Effect of Leucaena leaf meal substitution on Haematological indices in broiler chickens

	Diets						
Phase/parameters	**0%LLM**	**25%LLM**	**50%LLM**	**75%LLM**	**100%LLM**	**SEM**	**P-value**
Day 0-28 (n=30)							
Erythrocyte sedimentation rate	1.50	1.67	1.67	2.00	1.50	0.21	0.4809
Packed cell volume	32.33	31.67	32.00	30.00	32.67	0.87	0.2917
Red blood cell	247.00	238.00	243.50	202.17	254.17	17.75	0.3309
Heamoglobin	10.73	10.50	10.63	9.93	10.85	0.29	0.2755
Mean cell haemoglobin concentration	33.20	33.15	33.23	33.11	33.21	0.04	0.2306
Mean cell heamoglobin	0.44	0.46	0.44	0.50	0.43	0.02	0.3214
Mean cell volume	13.27	13.80	13.33	15.10	13.06	0.70	0.3130
Lymphocytes	59.50	57.83	58.50	59.00	57.17	1.84	0.9019
Neutrophils	24.83	25.33	26.33	23.33	25.50	1.02	0.3750
Monocytes	12.83	13.83	12.17	14.67	14.33	1.12	0.5049
Basophils	2.17	2.00	2.17	2.00	2.00	0.11	0.5801
Eosinophils	1.00	1.00	1.00	1.00	100	0.00	
Day 29-56 (n=60)							
Erythrocyte sedimentation rate	3.75^{a}	2.58^{d}	2.83^{c}	2.83^{c}	3.33^{b}	0.23	0.0283
Packed cell volume	25.67	27.58	27.25	27.17	26.42	0.51	0.1269
Red blood cell	163.17	182.17	178.83	176.42	167.08	6.82	0.3028
Heamoglobin	8.53	9.16	9.06	9.03	8.77	0.17	0.1230
Mean cell haemoglobin concentration	33.21	33.21	33.24	33.22	33.19	0.03	0.6498
Mean cell heamoglobin	0.54	0.51	0.51	0.52	0.53	0.01	0.4065
Mean cell volume	16.12	15.34	15.49	15.56	15.90	0.30	0.3859
Lymphocytes	58.08	58.58	58.50	59.33	59.00	0.72	0.7770
Neutrophils	25.33	24.17	24.67	24.50	24.17	0.42	0.3317
Monocytes	13.58	14.17	13.83	13.33	13.67	0.86	0.9682
Basophils	2.17	2.17	2.00	2.17	2.17	0.10	0.6896
Eosinophils	0.92	0.92	1.00	0.67	0.92	0.12	0.3882

**abc means along the same row with dissimilar superscripts are significantly different (p<0.05)*

Table 6. Effect of Leucaena leaf meal substitution on carcass characteristics in broiler chickens

	Diets						
Phase/parameters	**0%LLM**	**25%LLM**	**50%LLM**	**75%LLM**	**100%LLM**	**SEM**	**P-value**
Day 0-28 (n=30)							
Live weight	847.25^{a}	609.53^{cb}	611.43^{b}	450.03^{db}	391.67^{ed}	42.70	0.0002
Dressed weight	750.45^{a}	547.08^{cb}	559.37^{b}	421.28^{db}	360.80^{ed}	37.10	0.0002
Eviscerated weight	626.30^{a}	432.83^{cb}	435.88^{b}	304.65^{db}	270.85^{ed}	32.95	0.0001
Back	126.10^{a}	99.92^{a}	82.83^{a}	64.65^{ba}	51.13^{ca}	12.20	0.0106
Breast	165.97^{a}	108.38^{c}	111.35^{bc}	66.48^{bc}	59.10^{ed}	10.46	0.0002
Drumstick	72.67^{a}	48.72^{cb}	51.85^{b}	35.87^{dbc}	29.72^{ebcd}	4.35	0.0004
Thigh'	83.05^{a}	58.23^{a}	53.38^{ab}	43.62^{abc}	35.83^{acd}	6.21	0.0031
Wing	63.32^{a}	45.72^{c}	50.08^{bc}	34.57^{cd}	31.27^{ecd}	2.84	<0.0001
Neck	37.52^{a}	23.90^{b}	24.75^{bc}	16.93^{bd}	15.43^{bc}	2.12	0.0002
Head	24.30^{a}	20.10^{a}	19.08^{ab}	17.07^{ac}	15.58^{ad}	0.96	0.0008

	Diets						
Phase/parameters	**0%LLM**	**25%LLM**	**50%LLM**	**75%LLM**	**100%LLM**	**SEM**	**P-value**
Shank	36.05[a]	29.00[a]	25.22[ab]	21.33[bc]	19.12[bd]	1.65	0.0002
Day 29-56 (n=60)							
Live weight	1925[a]	1820[a]	1805[a]	1646[b]	1642[b]	65.1	0.0484
Dressed weight	1795[a]	1688[a]	1654[a]	1463[ab]	1479[c]	60.0	0.0109
Eviscerated weight	1504[a]	1421[a]	1408[a]	1250[b]	1212[c]	48.8	0.0082
Back	323	526	283	242	241	109	0.3788
Breast	376[a]	318[a]	327[a]	262[b]	284[b]	18.3	0.0120
Drumstick	182	166	175	175	163	11.5	0.7521
Thigh'	190	179	181	162	164	8.75	0.2089
Wing	150[a]	150[a]	149[a]	134[b]	130[b]	4.80	0.0295
Neck	74.0	64.7	65.1	59.8	59.5	5.83	0.4457
Head	46.6	44.1	45.3	43.2	44.3	1.44	0.5536
Shank	82.5	77.8	81.5	76.0	74.9	3.23	0.4243

**a, b, c means along the same row with dissimilar superscripts are significantly different (p<0.05)*

4. CONCLUSION

The study revealed that broiler finishers fed up to 50% *L. leucocephala* leaf meal-based diets performed better than those on the control. Therefore, up to about 50% replacement of soybean meal with LLM (diet 3) could be used to formulate broiler finishers diets without adverse effects on their performance.

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ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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