American Journal of Experimental Agriculture
3(3): 506-519, 2013

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Nutritional Potential of *Centrosema pubescens* *Mimosa invisa* and *Pueraria phaseoloides* Leaf Meals on Growth Performance Responses of Broiler Chickens

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Authors' contributions

This work was carried out in collaboration between authors FCN and GNE. Author FCN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author GNE managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

Research Article

Received 28th December 2012
Accepted 8th March 2013
Published 3rd May 2013

ABSTRACT

Aims: The objective of this study was to access the growth responses of chickens fed different leaf meal supplements.
Study Design: The experimental design used was completely randomized design for the chicks and completely randomized block design for the growing pullets and cockerels.
Place and Duration of Study: The experiments were carried out at Bora Poultry Unit of Federal College of Animal Health and Production Technology, Institute of Agricultural Research and Training (IAR&T) Ibadan, Nigeria. The experiments were carried out between the years 2004 to 2009.
Methodology: Nutritive potentials of *Centrosema pubescens*, *Mimosa invisa* and *Pueraria phaseoloides* leaf meals (LM) were determined and evaluated using different types of chicken within the years 2004-2009. The diets were formulated to contain 0,20/25, 30/40, 60/75 and 80/90g LM/kg feed and 120 to 150 birds were used in each experiment. Each treatment was replicated three times. All ingredients in each experiment were of constant

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weight, except the soybean and groundnut cake which test ingredients replaced some percentages weight for weight. Data on feed intake and weight gain were subjected to one-way ANOVA and comparisons were made using Duncan's Multiple Range Test.
Results: Results revealed that the LM are rich in crude protein (21.36-23.34%) and ash (4.25 – 9.14%). The most available mineral elements were potassium (0.45-1.85%) and calcium (0.60 – 1.726%). The concentration of tannin was highest in the LM (1.57-3.35g/100gDM) unlike oxalate (0.037-0.065g/100gDM). The poorest LM in terms of nutritive value and chicken performance was *Mimosa invisa* leaf meal (MLM), while the best was *Centrosema pubescens* leaf meal (CLM). Inclusion of 40 – 60gCLM/kg feed for Black Nera chicks and finisher pullets and 75gCLM/kg feed for broiler starters and finishers resulted to significant (P<0.05) reduction in feed intake and weight gain. Feed intake and weight gain of broiler starters and finishers and cockerel growers fed 20 – 60gMLM/kg feed supplements significantly (P<0.05) and progressively decreased with increased dietary concentration of MLM supplement. Broiler starters and finishers fed 30-90PLM/kg feed had increased feed intake, which was progressive, unlike their weight gain which depressed significantly (P<0.05) with increased concentration of *Pueraria phaseoloids* leaf meal (PLM).
Conclusion: Hence, 20 and 25g CLM/kg feed is recommended for pullet chicks/growing pullets and broiler chicken, respectively, while PLM and MLM are not recommended, for chicken nutrition due to depression in growth rate.

Keywords: Nutritive potential; legume leaf meal; growth responses; chicken.

1. INTRODUCTION

The rising cost of poultry feeds has continued to be a major problem in poultry industry in developing countries, as feed cost is about 65 to 70% of the total cost of production [1] compared to 50 to 65% in the developed countries [2]. High cost of conventional protein sources has necessitated the use of leaf meal supplements in poultry production. These leaf meals are readily available and cheaper than the conventional protein sources. Leaf meal supplements have been included into the diets of poultry as a means of reducing the high cost of conventional protein sources and to improve profit margin [3,4,5,6]. The importance of legume leaf meals in poultry has been recognized by farmers because of their relatively high content of proteins, some minerals and vitamins [3,7]. [10] indicated that a distinguished feature of tropical legumes in comparism with their temperate counterparts is the occurrence of a diverse array of non-protein amino acids in sufficient concentrations to precipitate adverse effects in farm animals.

Different leaf meals have been incorporated into poultry diets, incuding those of *Leucaenaleucocephal* [9], *Cnidoscolusaconitifolius* [10], *Manihotesculenta* [11,12], *Centrosema pubescens* [13,7], *Microdemispuberula* [14] among others. [34] recommended dietary addition of 5% of *Leucaenaleucocephala* leaf meal (LLLM) for improvement of body weight gain in chicks. [41] reported that dietary inclusion of LLLM more that (50g/Kg) caused reduced growth of broiler chicken and low egg production. [25] reported that 2.5% MLM reduced weight gain, while 7.5% significantly (P<0.05) reduced feed intake. [22] reported reduction in feed intake when broiler chickens were fed 15% *Centrosema pubescens* leaf meal (493.88g/bird) compared to 529.00, 532.51 and 516.40g/bird at 0.0, 5.0 and 10.0%, respectively. Hence, the objective of this study was to access the growth responses of chickens fed different leaf meal supplements.

2. MATERIALS AND METHODS

The experiments were carried out at Bora Poultry Unit of Federal College of Animal Health and Production Technology, Institute of Agricultural Research and Training (IAR&T) Ibadan, Nigeria. The experiments were carried out between the years 2004 to 2009 with the mean annual rainfall of 1398mm and mean monthly temperature of 22.71ºC and average monthly relative humidity of 75.54%. A total of 120 to 150 birds were used in each experiment. Tender leaves of *Centrosema pubescens, Mimosa invisa* and *Puerariaphaseoloides* were harvested from and around the paddocks in IAR&T. The leaves were detached from the vines/stems and were air and sun-dried for 2-3 days to a moisture content of about 12% (4). The dried leaves were milled/ground using a hammer mill with a sieve/screen size of 2.0-3.0mm. Samples of the leaf meals were collected for proximate and chemical analyses, while some were incorporated into the diets. Diets A,B,C, D and E contained 0,20/25, 30/40, 60/75 and 80/90g/kg feed of each forage meal, respectively.

The Black Nera chicks and growing pullets fed *Centrosema pubescens* (CEP) leaf meal supplement had four treatments each which contained 0, 20, 40 and 60g/kg CEP. The broiler starters and finisher fed *Centrosema pubescens* (CEP) leaf meal supplement had four treatments each which contained 0, 25, 50 and 75g/kg CEP. The Cockerel chicks fed *Mimosa invisa* (MIS) were placed on four treatments (0, 20, 40 and 60g/kg MIS), while cockerel growers were placed on three treatments (0, 30, and 60g/kg MIS). However, broiler starters and finishers which were fed MIS had four (0,20, 40 and 60 treatments, respectively. The broiler starters and finishers placed on *Pueraria phaseoloides* supplement (PPS) experiments had four (0, 30, 60 and 90g/kg) treatments in each phase. Treatment o in all the experiments served as control. Each treatment in the above experiment were replicated three times.

The diets were formulated according to [23] and [3] and ingredients were constant, except the test ingredient (the leaf meal), soybean meal and groundnut cake. The test ingredient replaced some percentages of soybean and groundnut cake in each experiment weight for weight. Gross composition of control diets is presented in Table 1. The birds were randomly allotted to the aforementioned dietary treatments in each experiment. Each treatment was replicated three times in a completely randomized design, but for growing pullets/pullet finishers and cockerel finishers, completely randomized block design was used. Data on feed intake were taken on daily basis, while weight gains were taken on weekly basis. Routine management practices and medication were taken as and when due.

Proximate and mineral composition of the test ingredients were determined by the procedures of [5] and proximate composition of the diets was determined by the methods of [2], while their metabolisable energy (ME) was determined by the methods of outlined by [6]. Gross energy of the test ingredients was estimated by the method of [1]. Phytate was determined by the technique of [16], while tannin was evaluated by the method outlined [15] and oxalate by the procedures of [45].

Data on feed intake feed, weight gain and feed conversion ratio were subjected to one-way ANOVA analysis of variance procedure of [40]. Duncan's Multiple Range Test (28) was used in assessing the significant differences among the treatments.

3. RESULTS

The results revealed that the leaf meals (LM) studied are rich in crude protein (CP). The crude fibre (CF) contents of these LM are moderate, most especially for C. *pubescent* leaf meal (CLM), while *P. phaseoloides* leaf meal (PLM) is very high in CF (Table 2). The CLM and PLM are rich in ash, while *M*. *invisa* leaf meal (MLM) is very low in ash. The CLM and MLM are rich in calcium, potassium and phosphorus. The PLM had the least calcium and potassium. The LM have moderate concentrations of magnesium and sodium, while the concentration of phosphorus in the PLM is the lowest. The concentrations of zinc and iron of the LM are moderate. The concentrations of oxalate, phytate and tannin in these LM are presented in Table 2. The most available anti-nutritional factor was tannin.

Feed intake, weight gain and feed conversion ratios of Black Nera chicks, Black Nera growing pullets, broiler starters and finishers fed graded levels of *Centrosema pubescens* leaf meal were significant ($P<0.05$) (Table 3). Dietary inclusion of 2 to 6% CLM supplements for Black Nera chicks resulted to increased feed intake and depression in both weight gain and feed conversion ratio compared to the birds placed on control diet. However, the best performance for Black Nera growing pullets in terms of weight gain was observed on the birds placed on 2% CLM, which also had elevated feed intake. Dietary inclusion of 2.5 to 5.0% CLM for broiler starters and finishers resulted to elevated feed intake which depressed at 7.5% (Table 3).

Inclusion of more than 20g/kg *Mimosa invisa* leaf meal to the diets of cockerel chicks resulted to lower feed intake and depressed weight gain and feed conversion ratio (Table 4). Similar scenario was observed for cockerel growers fed graded levels of *Mimosa invisa* leaf meal. Dietary inclusion o*f Mimosa invasa* leaf meal in broiler starters and finishers diets resulted to significant ($P<0.05$) reduction in feed, weight gain and feed conversion ratio, which were progressive. Broiler starters and finisher fed graded levels of *Pueraria phaseoloides* leaf meal had reduced weight gain and feed conversion ratio which were significant ($P<0.05$) and progressive compared to control (Table 5).

Table 1. Gross composition of control diets

Ingredients%	Pullet Chicks (0-6wks)	Growing pullets (8-16wks)	Broiler chicks (1-5wks)	Broiler finishers (5-8wks)	Cockerel chicks (0-9wks	Cockerel growers (10-18wks)	Broiler chicks (0-4wks)	Broiler finishers (4-8wks)	Broiler starters (0-4kws)	Broiler finishers (4-8wks)
	Centrosema pubescens				***Mimosa invasa***		***Pureria phaseoloides***			
Maize	31.6	20.3	48.0	51.5	30.0	24.3	44.0	45.3	46.8	48.8
Corn bran	21.0	23.4	14.0	17.2	26.6	22.0	13.0	13.8	10.0	11.0
Palm kernel cake	12.0	21.0	-	-	9.0	20.4	-	-	5.2	5.2
Coca pod husk	8.5	9.5	-	-	10.0	8.0	5.0	5.0	-	-
Soybean meal	14.6	11.0	21.2	17.5	13.0	11.1	20.6	20.0	20.4	19.4
Groundnut cake	6.5	6.5	9.5	7.0	4.0	6.4	10.0	9.0	10.3	9.3
Leaf meal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fish meal	2.0	3.5	4.0	3.0	4.2	3.5	4.0	3.5	4.0	3.0
Bone meal	2.0	2.5	2.5	3.0	2.3	3.5	2.6	2.6	2.5	2.5
Oyster shell	1.0	1.5	-	-	-	-	-	-	-	-
Salt	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Vitamin-mineral premix*,+	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3
Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Methionine	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1
Calculated analysis										
Crude protein(%)	19.0	18.9	22.0	18.8	18.7	20.3	22.0	21.2	22.6	21.3
Crude fibre(%)	6.9	8.8	4.5	4.4	6.8	7.6	5.4	5.4	4.3	4.4
Metabolisable energy (Kcal/kg)	2640	2526	2936	2966	2646	2436	2882	2889	2909	2932
Determined analysis										
Crude protein (%)	20.5	20.7	22.6	20.1	19.2	18.9	22.2	20.0	23.6	23.6
Crude fibre (%)	8.2	6.9	4.6	4.6	6.8	7.6	5.0	4.6	3.8	3.9
Metabolisable energy (Kcal/kg)	2740	2700	3100	3195	2700	2500	3001	3004	3000	3012

**Vitamin-mineral premix provides per kg of diet: Vit A=10000in, Vit D3= 1500iu;Vit E=3iu,Vit B12=0.08mg;Vit.K=2mg;Ribofl=3mgProduction acid=6mg; Niacin=15mg; chlorine=3mg;Folic acid=4mg, Mn=8mg,Zn=0.5mg;iodine=1.0mg;Co=1.2mg;Cu=10mg and Fe=20mg.*

+Vit.-mineral premix provides per kg diet: Vit A=12,500, 000iu, Vit D3=2,500,000iu; Vit E=25,000iu; Vit.K = 2.00mg; Vit. B1=2.00mg; Cu=6.00mg; Fe=40.00mg; iodine=1.00mg; Cobalt-0.2mg; Selenium =0.15mg; Choline chloride = 500.00mg.

- *For cockerels and pullet chicks/growers*

+For broiler starters/finishers.

Table 2. Proximate chemical composition of experimental test ingredients (% DM Basis)

Experiment test ingredients			
Fraction	***Centrosema* leaf meal**	***Mimosa* leaf meal**	***Pueraria* leaf meal**
Dry mater	88.99	89.99	89.90
Crude protein	23.24	23.34	21.36
Crude fibre	8.80	11.29	21.52
Ether extract	3.32	2.38	3.20
Ash	9.14	4.25	8.00
Nitrogen free extract (NFE)	55.50	58.74	45.92
Calcium	1.22	1.26	0.60
Potassium	1.85	1.60	0.45
Phosphorus	0.54	0.38	0.12
Magnesium	0.30	0.24	0.28
Sodium	0.17	0.15	0.11
Zinc (mg/kg/DM)	40.01	40.00	20.00
Iron (mg/kgDM)	20.01	10.11	80.10
Oxalate (g/100g DM)	0.037	0.065	0.060
Phytate (g/100g DM)	0.48	0.37	0.32
Tannin (g/100g DM)	2.81	1.57	3.35
Gross energy (kcal/kg)*	4354	4628	4419

Estimated by AFRC

Table 3. Feed intake and growth responses of chickens fed graded levels of *Centrosema pubescens* leaf meal

Dietary level of leaf meal (g/kg)									
Source of leaf meal	**Type of chicken**	**0**	**20**	**25**	**40**	**50**	**60**	**75**	**SEM**
		Feed intake and weight gain (g/bird)							
Centrosema Pubescens	Black Nera chicks (0-6 wks)	964^{d} / 339^{a}	1010^{a} / 285^{b}	-	984^{c} / 234^{d}	-	998^{b} / 248^{c}	-	3.3 / 4.1
	Black Nera growing pullets/finisher pullet (8-16wks)	6469^{b} / 699^{c}	6658^{a} / 740^{a}	-	6093^{d} / 719^{b}	-	6199c / 734ab	-	1.8 / 5.8
	Broiler chicks/starters (1-5 wks)	2300^{b} / 1009^{c}	-	2420^{a} / 1369a	-	2410^{a} / 1285^{ab}	-	2260^{b} / 1238^{b}	12.2 / 27.7
	Broiler Finishers (5-8 weeks)	3210^{a} / 792^{b}	-	3100^{a} / 1001^{a}	-	3200^{a} / 985^{a}	-	2860^{b} / 562^{c}	30.9 / 24.0
Feed conversion ratio									
	Black Nera chicks (0-6wks)	2.81^{c}	3.51^{b}	-	4.20^{a}	-	4.00^{a}	-	0.11
	Black Nera growing pullets/finisher pullets (8-16wks)	9.31^{a}	9.00^{ab}	-	8.50^{b}	-	8.41^{b}	-	0.51
	Broiler chicks/starter (1-5 wks)	2.31^{a}	-	1.81^{b}	-	1.90^{b}	-	1.80^{b}	0.07
	Broiler finisher s (5-8 wks)	4.10^{b}	-	3.10^{d}	-	3.31^{c}	-	5.10^{a}	0.17

abcd: Means with different superscripts on the same horizontal row differ significantly(P<0.05),WKS=weeks Numerator = Feed intake; Denominator = Weight gain

Table 4. Feed intake and growth responses of chickens fed graded levels of *Mimosa invisa* leaf meal

Dietary level of leaf meal (g/kg)							
Source of leaf meal	**Type of chicken**	**0**	**20**	**30**	**40**	**60**	**SEM**
		Feed intake and weigh gain (g/kg)					
Mimosa invisa	Cockerel chicks (0-9wks)	2908^{c} / 517^{d}	3142^{a} / 644^{a}	-	2706^{d} / 553^{c}	3082^{b} / 588^{b}	3.0 / 3.5
	Cockerel growers/ finisher (10-18weeks)	8800^{a} / 1058^{a}	-	8783^{b} / 853^{b}	-	8166^{c} / 820^{c}	3.3 / 15.7
	Broiler chicks (0-4 wks)	1282^{a} / 538^{a}	1235^{b} / 504^{b}	-	1174^{d} / 505^{b}	1204^{c} / 403^{bc}	1.6 / 5.5
	Broiler finisher g/bird (4-8 wks)	3741^{a} / 659^{a}	3642^{b} / 413^{b}	-	3371^{d} / 400^{c}	-	2.0 / 3.0
Feed conversion ratio							
	Cockerel chicks (0-9wks)	5.61^{a}	4.90^{c}	-	5.10^{b}	5.20^{b}	0.09
	Broiler chicks(0-4 wks)	8.30^{b}	-	10.30^{a}	-	10.00	0.82
	Broiler finisher (4-8wks)	2.40^{b}	2.51^{b}	-	2.30^{b}	3.00^{a}	0.03
	Broiler finisher (0-4 wks)	5.91^{a}	8.80^{b}	-	8.41^{b}	8.60^{b}	0.05

Abcd: means with different superscripts on the same horizontal row differ significantly ($p<0.05$);
WKS = Weeks; Numerator = Feed in take; Denomminator = Weight gain

Table 5. Feed intake and growth responses of chickens fed graded levels of *Pueraria phaseoloides* leaf meal

Dietary level of leaf meal (g/kg)						
Source of lead meal	**Type of chicken**	**0**	**30**	**60**	**90**	**SEM**
		Feed intake and weight gain				
Pueraria phaseoloides	Broiler starter(0-4 wks)	1202[b] / 536[a]	1122[b] / 479[b]	1234[a] / 453[c]	1246[a] / 399[d]	0.7 / 0.7
	Broiler finisher (4-8 wks)	4306[d] / 1466[a]	4387[c] / 1370[b]	4492[a] / 1354[c]	4446[b] / 1341[d]	0.7 / 0.6
		Feed conversion ratio				
	Broiler starter (0-4 wks)	2.20[c]	2.30[c]	2.70[b]	3.10[a]	0.22
	Broiler finisher (4-8 wks)	2.90[b]	3.20[a]	3.30[a]	3.30[a]	0.24

abcd: Means with different superscripts on the same horizontal row differ significantly (P<0.05)
Numerator =Feed intake; Denominator= Weight gain; WKS = Weeks.

4. DISCUSSION

The leaf meals (LM) studied are moderate in crude fibre (CF), except PLM. The relatively high CP and low CF with high concentration of ash will necessitate the use of CLM and PLM as protein and mineral supplements in chicken production. [4] revealed that some tropical legumes have higher nutritive value and that the availability of the component amino acids in the small intestine would be more when the leguimous forage materials are fed dried than when fresh. The CP value of CLM in this study is higher than the report of [4], but similar to that of [24] (19.6%) and [37] (21.4%). [49] reported that *C. pubescens* contained 20.0% CP, with CF of 30.0%, while [28] noted that *C. pubescens* harvested at 12 weeks after planting contained 18.70% CP, 11.80%CF,6.98% ash and other extract of 4.42%. [9] highlighted that *M. invisa* leaves contained 16.2 and 37.2% of CP and CF, respectively. The gross energy (GE) of the LM was 4354, 4419 and 4628Kcal/kg, for CLM, PLM and MLM, respectively. These values are in harmony with the reports of [44] who reported that tropical legumes have GE of *4326-4802*KcalKg. [37] reported that GE of CLM was 3885Kcal/kg, while that of PLM was 3872Kcal/kg. The variations in the CP,CF GE and EE could be attributed to the age of cutting, climatic conditions, methods of processing and analyses. Concentrations of calcium and potassium which were highest in the CLM and MLM are in line with the submission of [4] who stated that calcium, potassium and sodium were the most available mineral elements in forage meals. Calcium and phosphorus concentrations for CLM in this study are higher than that reported by [37] whose value were 0.72 and 0.23% for calcium and phosphorus, respectively, but they are in harmony with the reports of [14,17] who reported 0.78 – 1.36% for calcium and 0.13-0.45% for phosphorus. [21] reported that MLM contained 0.14% phosphorus which is lower than reported in this study. The report of [9] on the calcium content of MLM (1.10%) is slightly lower than reported here (1.26%). The calcium content of PLM in this study is relatively lower than the results of [21,44,18] (0.36 – 1.72%). The values of phosphorus and magnesium reported in this study are lower than the values of [18].

The diets for the chickens met the nutritional requirements of the birds are in line with standards of [23]. Dietary inclusion of *Centrosema pubscens* meal in the diets of broilers, cockerel chicks/finishers and pullet chicks/growers significantly (P<0.05) resulted to reduced feed intake unlike the broilers fed graded levels of *Pueraria phaseoloides* leaf meal (PLM). At both phases, feed intake of broilers fed 30-90PLM/kg feed increased with increased dietary inclusion of PLM supplements. This observation for the broilers fed PLM supplements is contrary to the submission of [26,12,48]. The increased feed intake for the broiler fed PLM supplements is associated with the lightweight of the PLM leaf meal and its lower energy. However, the weight gain of the broilers fed PLM supplements significantly (P<0.05) and progressively decreased with increased dietary concentrions of PLM. This observation is not in line with the reports of [22,35,32].

Dietary inclusion of 20-60kg *Mimosa invisa* leaf meal (MLM) in cockerel finishers, broiler starters and finishers resulted to depressed weight gain and feed conversion ratio which were significant (P<0.05) and progressive. Poor performance of these birds is attributed to the presence of mimosine in the MLM [44], low acceptability [36] and poor digestibility [8]. These results are in harmony with the reports of [48], but contradict, the submission of [32].

Black Nera pullets tolerated the dietary inclusion of CLM in their diets more than the Black Nera chicks, as they had improved growth rate. Inclusion of 2-6g CLM/kg feed in the diets of the Black Nera chicks resulted to 15.93 – 30.90% depression in growth over control. This result is contrary to the report of [35] who concluded that 50-100gCLM/kg feed resulted to elevation of weight gain. However, this result agrees with earlier observations that dietary inclusion of leaf meal of *L. leucocephala,* (4and 8) and Alchornia *cordifolic* (46) depressed feed intake, weight gain and feed conversion ratio. Dietary inclusion of 25g CLM/kg feed for broiler starters resulted to 26.34 and 9.60% increase in weight gain over control and 75g CLM/kg feed, respectively. However, for broiler finishers, the increase in weight gain for 25gCLM/kg feed was 56.12% due to prolonged feeding, as the feeding was continuous from starter to finisher phase (i.e. 7 weeks). These results are contrary to the reports of[35], but agree with the submission of [31] when broiler chicks were fed graded leaves of *Tithoniadiversifolia* and [7] who recommended 2% of *L. leucocephala* leaf meal for broiler starters and 3% for chick starters. [8]recommended 25g *Cindoscolusaconitifolius* leaf meal per kilogramme of feed for optimal chickens performances, while [25],[29] concluded that 25gMLM/kg feed was adequate for broiler chicks and finisher maximum performance.

5. CONCLUSION

The leaf meal (LM) studied are rich in crude protein (21.36 – 23.24%) and ash (4.25-9.14%). The most available mineral elements were potassium (0.45-1.8%) and calcium (0.60-1.26%). *Centrosema pubescens* leaf meal (CLM) is the most outstaniding in mineral profile, nutritive value and chickens performance, while *Mimosa invisa* leaf meal (MLM) is the poorest. Broiler starters/finishers, cockerel chicks/growers and pullet chicks/finishers tolerated the CLM, CLM and PLM supplements differently. Dietary inclusion of 40-75g CLM/kg feed and 30-60 gMLM/kg feed resulted to depressed feed intake in the chickens, unlike the inclusion of 30-90PLM/kg feed which improved feed intake. Dietary inclusion of 75g CLM/kg, 30-60MLM/kg and 30 – 90PLM/kg feed resulted to depressed growth performance. For improved performance and adequate growth rate, it is advisable to include 20gCLM/kg feed in the diets of pullet chicks and growing pullets, while 25g CLM/kg feed is adequate for broiler chicks and broiler finishers. However, it is not advisable to include MLM and PLM in the diets of pullet chicks/growers, cockerel chicks/finishers and broiler chicks/finishers due to poor growth rate.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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