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CENTROSEMA (*Centrosema pubescens*) LEAF MEAL AS A PROTEIN SUPPLEMENT FOR BROILER CHICKS PRODUCTION

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ABSTRACT

Present study was conducted to find out the potential *Centrosema pubescens* leaf meal as a protein supplement for the broiler chicks production. For this, Ninety unsexed one week old Anak 2000 broiler chicks were used. These selected chicks were randomly allotted to 5 dietary treatments i.e. A (*Centrosema* free diet), B (3%), C (6%), D (9%) and E (12%) with different concentration of *C. pubescens* leaf meal (CLM). Each treatment was replicated 3 times with 6 birds per replicate. This CLM mainly used to replaced groundnut cake and soybean in the diets. Water and feeds were served *adlibitum*. The results of study revealed that dietary supplementation of CLM significantly ($P<0.05$) and progressively depressed final body weight, weight gain and feed conversion ratio unlike water and feed intakes. Dietary inclusion of 6-12% CLM for broiler chicks reduced weight gain averagely by 12.96% compared to control. The cost of feed per kg live weight gain was ₦91.86, ₦96.04 and ₦107.59/kg for control, 3 and 12%, respectively. Profit margin was highest in control (₦4.11) and birds placed on 3% CLM (₦2.66) per bird compared to those fed 9.0-12.0% CLM dietary inclusion, in which average loss was ₦20.39 per bird. Hence results of study clearly advised that CLM can be add as protein supplements but it should not include more than 3% in the diet of broiler chicks.

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1 Introduction

Eggs and poultry meat can play a significant role in overcoming protein malnutrition which is a common problem in many African countries (Daghir, 1995). High yielding exotic poultry have ability to adopt climatic conditions of these countries and also have considerable potential in fulfilling this protein gap (Madubike, 1992). Above mentioned facts clearly suggesting the importance of poultry industry in African continents but this industry face problems like high cost of feed and financial unavailability. Continuous rising cost of poultry feeds is a major problem for developing countries, feed cost is about 65 - 80% of total cost of production (Opara, 1996; Nworgu et al., 1999; Nworgu, 2004) and it is very high as compared to developed countries where it comes about 50 - 60% only (Tackie & Flenscher, 1995). According to Esonu et al. (2001) more than 50% of the Nigerian poultry farms have closed down and another 30% were forced to reduce their production capacity due to high cost of feeds. The reason behind this bulk feed cost rising is the type and concentration of protein supplementation with poultry diets. The prices of protein supplements such as groundnut cake, fish meal, soybean meal and cereal/maize soar continually, most especially from December to June every year in Nigeria. Therefore, there is a need of finding out some locally available, affordable and relatively all year round available alternate protein supplementation of unconventional protein, which can reduce cost of production.

One of the possible sources of cheap protein is the leaf meal of some tropical legumes and browse plants (Nworgu & Fapohunda, 2002; Esonu et al., 2003). Leaf meal made from the leaf of fodder shrubs helping small-scale farmers of Tanzania to boost their income through poultry business (WAC, 2006). The author noted that several hundred rural women of Tanzania collected leaves of *Leucaena spp.* from the forest, dried these leaves and process into meal for cattle and package them into bags for sale. Leaf meal supplements have been also included into the diets of poultry birds as a means of increasing weight and reducing cost of production (Topps, 1992; Odunsi et al., 1999; Nworgu & Fapohunda, 2002; Esonu et al., 2003; Nworgu et al., 2012). Various leaf meals such as *Leucaena* (Udedibie&Igwe, 1989), *Amaranthus* (Fragaset al., 1993) and *Centrosema* (Ngodigha, 1994; Nworgu 2004) have been previously used in poultry diets by various researchers. Aletor (1986) extensively reviewed the nutritional potentials of some non-conventional feedstuffs and reported that incorporation of these non-conventional feedstuffs at high levels can be reduce the quality of a feeds and may also have negative effect on the organism. In this context, D'Mello (1995) recommended 5 - 10% dietary inclusion levels of leaf meals for broiler chicks and laying hens, respectively. Furthermore, Nworgu (2004) and Nworgu et al. (2005) recommended only 2% *Mimosa invisa* and *Pueraria phaseoloides* leaf meals for broiler chicken and broiler chicks, respectively, while Nworgu (2004) reported that 2.5% *Centrosema pubescens* leaf meal (CLM) was adequate for

broiler starters and finishers growth. However, negative effect of overdose of CLM was reported by Omeje et al. (1997), they have concluded that 5 - 10 % dietary inclusion of CLM resulted to elevation of weight gain for broiler chicken. A controversial observation was also reported by Esonu et al. (2003), they suggested that 10% dietary inclusion of *Microdesmia puberula* leaf meal could be used in broiler finisher diets. Furthermore, Odunsi (2003) recommended 10 and 15% (100 and 150 g/kg) of *Lablab purpureus* leaf meal for laying hens.

Efficiency of feed and labor utilization is a very important means of increasing profit in any poultry enterprise. Nworgu et al. (2000) revealed that profit margin in poultry production depended mainly on feed utilization, cost of day-old chicks and efficient management of resources. Nworgu et al. (1999) reported that profit margin in broiler production in Ibadan ranged from ₦3.15 to ₦51.36 per bird compared to ₦30.80 in Zaria (Ogundipe, 1998) and ₦44.60 in Owerri (Nwajiuba, 1998). However, profit margin in broiler/poultry production in Nigeria is sensitive to time of sales.

Information regarding the use of CLM as protein supplement in broiler production is relatively limited in study area while the availability of *C. pubescens* is in abundance (Skernman et al, 1988; D'Mello, 1995). Hence the objective of this study was to assess the performance of CLM supplementation on broiler chicks.

2 Materials and Methods

Present study was carried out at Research Farm of the Federal College of Animal Health and Production Technology, Institute of Agricultural Research and Training, Ibadan, Nigeria. The Research Farm is located on 03°51'E Longitude and 07°23'N Latitude. Altitude of the study area was 650m, the environmental condition are humid tropical southwestern Nigeria with annual rainfall of 1220mm and mean monthly temperature of 26°C within the period of the experiment.

Ninety unsexed one week old Anak 2000 broiler chicks were randomly distributed to five dietary treatments which contained 0, 3, 6, 9 and 12% *C. pubescens* leaf meal (CLM) for treatments A, B, C, D and E, respectively in a completely randomized design (Table 1). Treatment A served as control (without CLM). Each treatment was replicated three times with six birds per replicate. The experiment lasted for five weeks. The leaf meal was prepared as described by D'Mello (1995). Relatively young leaves of *C. pubescens* were harvested from ungrazed paddocks within the Institute. The leaves were detached from the vines and were air and sun dried up to a moisture content 120 gkg⁻¹(12%) as stipulated by D'Mello (1995). The dried leaves were milled using a hammer mill with a sieve/screen size of 3.36mm to produce leaf meal, which was then incorporated into the diets. The CLM mainly substituted groundnut cake and soybean meal in the diets of broilers for weight.

Table 1 Gross composition of experimental broiler chicks diets (%)

Diet Ingredients	Dietary Treatments				
	A	B	C	D	E
Maize	44.00	44.05	44.00	44.00	43.00
Com bran	18.05	19.00	18.00	17.00	17.00
Soybean	20.60	17.60	16.50	15.50	13.50
Groundnut cake	10.00	9.00	8.15	7.15	7.15
CLM level	0.00	3.00	6.00	9.00	12.00
Fish meal	4.00	4.00	4.00	4.00	4.00
Bone meal	2.60	2.60	2.60	2.60	2.60
Vitamin/mineral premix*	0.30	0.30	0.30	0.30	0.30
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Calculated Analysis					
Crude protein (%)	22.28	21.50	21.45	21.15	21.04
Crude fibre (%)	4.72	4.46	4.29	4.25	4.27
Metabolizable energy (Kcal/kg)	2997	2983	2966	2947	2918

CLM = Centrosema leaf meal ; *Bimba Agro-Mix for broilers and chicks. Dosage use 3.0kg / ton of feed

Table 2 Proximate composition of test ingredient (*Centrosema* leaf meal) and determined proximate composition of experimental diets (Based on the percentage Dry Mass).

Fraction	CLM (Absolute)	Dietary Treatments				
		A (0%)	B (3%)	C (6%)	D (9%)	E (12%)
Dry matter	89.92	93.08	92.84	93.22	92.94	92.81
Crude protein	24.89	22.48	22.04	22.12	21.60	21.68
Crude fiber	8.94	4.83	5.24	5.89	6.02	7.29
Ash content	9.12	10.04	9.20	9.12	9.15	9.67
Ether extract	3.35	7.80	6.94	6.87	6.81	7.02
Nitrogen free extract	53.70	54.25	56.58	56.02	56.42	54.34
Gross energy (Kcal/kg) ⁺	4454	-	-	-	-	-
Metabolizable energy (Kcal/kg) ⁺⁺		3296	3291	3275	3259	3206

CLM: *Centrosemapubescens* leaf meal ; + = Estimated by Peiretti (2005) ++ = Estimated by Panzenga (1985)

Feeds and water were supplied *ad-libitum*. Routine management practices and medication were carried out according to regular practices. The birds were raised on deep litter floor covered with wood shavings. Each pen measured 1.5 m by 2 m. The pens used were covered with cellophane sheets and sacks for brooding, which lasted for two weeks. Thereafter wood shaving was used which was changed forth nightly. Provision of footbath was also made available. Data on feed and water intake were taken on daily basis, while weight gain was recorded on weekly basis and feed conversion ratio (FCR) was calculated based on the data from feed intake and weight gain. The proximate composition of the CLM and diets was determined by the methods of AOAC (1990), while the gross energy was determined according to Peiretti (2005) ($4354 + 2.131CP \pm 14$). Data collected were subjected to analysis of variance, while Duncan's New Multiple Range Test as outlined by Obi (1990) was used to assess the significant differences. Gross composition of feed used is presented in Table 1. The experimental diets were formulated at Dominion

Livestock Feeds at Owode Estate fortnightly for quality preservation.

An economic appraisal of the study was done to highlight the efficiency of the CLM in terms of profits margin. The cost of labor and depreciation was calculated according to WBTP (1983). Some data were analyzed using descriptive and budgetary techniques (Akinsoye, 1989). The total cost of production, net profit and cost benefit ratio were determined as presented herein:

$$TCP = TFC + TVC \quad \dots(1)$$

Where

TCP = Total cost of production

TFC = Total fixed cost

TVC = Total variable cost

$$NP = TR - TCP \quad \dots(2)$$

Where:

NP = Net profit in naira (N150 = \$1)

TR = Total revenue

$$NP = NR - NFI \quad \dots(3)$$

Where:

NR = Net return and

NFI = Net farm income

$$GM = TR - TVC \quad \dots(4)$$

Where:

GM = Gross margin

The profitability ratios were employed to explain vividly the extent to which the factors of production were used for profit maximization thus:

$$BCR = TR/TCP \quad \dots(5)$$

BCR = Benefit cost ratio or capital turnover

$$RRI (\%) = NP/TCP \times 100 \quad \dots(6)$$

RRI = Rate of returns on investment

$$GR (\text{Gross ratio}) = TCP/TR \quad \dots(7)$$

P1 (Profitability index) = NFI / GR = NP/TR

GR = Gross revenue = total return

RRI = Rate of return on investment

3 Results and Discussion

Results of the proximate composition were represented in table 2. Determined proximate composition of CLM indicated that it is highly rich in crude protein (24.89%) and gross energy (GE - 4355.53kcal/kg) while the diet has moderate crude fiber (8.94%) and ash (9.12%). The diets used in this study met the nutritional requirements of broiler chicks and are in line with

the standards of NRC (1994). The crude protein (CP) content of the present study materials shows the similarity with the findings of Raharjo et al. (1986), Nworgu et al. (2001) and Nworgu (2004), but the submission of Aletor & Omodara (1994) was reported lower than 12.50% the present study. Furthermore, Wilson & Lansbury (1959) reported that CLM contained 20% CP and 30% CF while Nworgu & Ajayi (2005) reported that CLM harvested at the age of 12 weeks, contained 18.70, 11.80 and 6.98% of CP, CF and ash, respectively. The GE of CLM (4355 kcal/kg) is within the range reported by Raharjo et al. (1986) (4326-4802 kcal/kg) for tropical legumes.

The results of final body weight (FBW), mean body weight gain (MBWG) and feed conversion ratio (FCR) are significantly different ($P < 0.05$) and progressively decreased with increased dietary concentrations of CLM (Table 3). Similar observation was made by Nworgu & Fapohunda (2002) when broiler chicks were fed graded levels of CLM and Nworgu (2004) when broiler chickens were fed more than 5% dietary inclusion of CLM. The value of the FCR (2.46 – 3.15) in this study is higher (2.03 – 2.13) than the reports of Ayanwale (1999). The results of this trial tended to agree with earlier observation that dietary inclusion of leaf meals of *L. leucocephala*, *G. sepium*, *C. cajon*, *S. sesban* and *M. esculenta* depressed growth, feed intake, FCR and growth rates of chicks at levels ranging from 75 - 100g/kg (D'Mello et al., 1987; Raharjo et al., 1988; Udedibie & Igwe 1989; Ogbonna & Oredein 1998; Nworgu 2004). However, results of the present study clearly represented that inclusion of 3% and above CLM depressed growth rate. The present results on weight gain are contrary to the submission of Omeje et al. (1997) who concluded that 5 -10 percent CLM resulted to elevation of weight gain in broiler chickens.

Table 3 Performance of broiler chicks fed experimental diets.

Parameters	Dietary Treatments					SEM
	A	B	C	D	E	
Initial live weight (g/bird)	85.41	84.00	84.50	85.41	84.30	-
Final body weight (g/bird)	745.80 ^a	745.40 ^a	710.04 ^c	640.9 ^b	627.2 ^d	0.89
Mean body weight gain (g/bird)	660.39 ^a	661.40 ^a	625.90 ^b	555.49 ^c	542.90 ^c	1.04
Average daily weight gain (g/bird)	18.87 ^a	18.89 ^a	17.88 ^{ab}	16.6 ^b	15.51 ^c	0.89
Total feed intake (g/bird)	1622.40 ^b	1759.54 ^a	1752.18 ^a	1748.14 ^a	1748.98 ^a	0.90
Average daily feed intake (g/bird)	46.35 ^b	50.28 ^a	50.06 ^a	49.94 ^a	49.96 ^a	1.00
Feed conversion ratio (FCR)	2.46 ^c	2.66 ^{ab}	2.80 ^b	3.15 ^a	2.79 ^b	0.23
Total water intake (ml/bird)	3502.82 ^d	3854.22 ^a	3720.84 ^c	3781.57 ^b	3798.90 ^b	1.09
Average daily water intake (ml/bird)	100.10 ^c	110.11 ^a	106.31 ^b	108.02 ^{ab}	108.54 ^{ab}	0.87
Feed: Water intake ratio	1:2.16	1:2.19	1:2.12	1:2.08	1:2.17	-
Cost of 1 kg of feed (N/kg)	37.40	36.10	35.30	34.50	33.40	-
Cost of feed consumed (N/kg)	60.67	63.52	61.85	60.31	58.41	-
Cost of feed per kg live weight (N/kg)	91.80	96.04	93.81	108.57	107.59	-

abcd: Means with different superscripts on the same row differ significantly ($P < 0.05$)

Table 4 Average production cost and return for intensive broiler chicks management.

Value per bird and percentage of total cost										
Items	A	%	B	%	C	%	D	%	E	%
1. Revenue (N)										
Sale of broiler chicks	186.45		186.35		177.60		160.23		156.80	
(250.00/kg) live-weight	0.13		0.16		0.15		0.15		0.148	
Sale of manure N0.20/kg	186.58		186.51		177.75		160.38		156.94	
Total (TR)										
2. Variable cost of production(N)	62.17	4.07	63.52	35.69	56.69	32.01	60.31	33.52	58.42	32.49
Feed	0.70	0.39	0.77	0.44	0.66	0.38	0.76	0.43	0.76	0.45
Water (0.20/litre)	90.00	49.32	90.00	50.507	90.00	50.86	90.00	50.02	90.00	50.51
Day old chicks	3.50	1.92	3.50	1.96	3.50	2.24	3.50	1.94	3.50	1.96
Labor	3.40	1.86	3.40	1.91	3.40	1.92	3.40	1.93	3.40	1.94
Drugs	6.50	3.56	6.50	3.66	6.50	3.67	6.50	3.61	6.50	3.65
Vaccines	9.90	5.43	9.90	5.57	9.90	5.59	9.90	5.50	9.90	5.56
Medication	0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.05
Maintenance & repair	0.13	0.08	0.13	0.08	0.13	0.07	0.13	0.08	0.13	0.07
Transport	0.59	0.32	0.55	0.03	0.55	0.31	-	-	-	-
Tax (3k/N)	0.13	0.08	0.13	0.08	0.13	0.07	0.13	0.08	0.13	0.07
Miscellaneous	177.12	97.06	178.50	94.70	171.56	96.97	174.55	97.03	172.84	96.99
Total variable cost (TVC)										
3. Fixed cost of production(N)										
Housing (depreciation over 10 years)	1.80	0.99	1.80	0.98	1.80	1.02	1.80	1.00	1.80	1.00
	2.30	1.26	2.30	1.29	2.30	1.30	2.30	1.28	2.30	1.29
Interest on loan	1.25	0.69	1.25	0.71	1.25	0.71	1.25	0.691	1.25	0.70
Equipment (depreciation over 5 years)										
4. Total fixed cost (TFC) (N)	5.35	2.94	5.35	2.94	5.25	3.03	5.35	2.97	5.35	2.99
Total cost of production (TCP = (TVC + TFC)	182.47	100.00	183.85	100.00	176.91	100.00	179.90	100.00	178.19	100.00
	4.11	-	2.66	-	0.84	-	-19.52	-	-21.25	-
Net profit/loss (TR – TCP) (N)	2.25	-	1.45	-	0.47	-	-10.85	-	-11.92	-
Rate of return on investment (RRI) = NP x 100% (%) TCP	1:1.02	-	1:1.01	-	1:1.00	-	1:0.89	-	1:0.88	-
Benefit cost ratio (BCR = TR/TCP)	1:0.98	-	1:0.99	-	1:1.03	-	1:1.12	-	1:1.34	-
Gross ratio (TCP/TR)										

₦150 = \$1

Variation in the results could be ascribed to the age of cutting of the *C. pubescens* leaves, as older leaves are more fibrous (D'Mello, 1995; Nworgu, 2004). However, Esonu et al. (2003) reported that broiler chicks fed on 0.0, 5.0 and 10.0 percent *Microdesmis puberula* leaf meal had final body weight gain of 600.00, 550.00 and 551.00g/bird, respectively which agrees with the present study. Similarly, Ngodigha (1994) reported that broiler chickens fed on 0.0, 5.0, 10.0 and 15.0% CLM supplements had final body weight of 1690, 1630, 1490 and 1280g/bird, respectively and concluded that broiler chickens can tolerate up to 15% CLM supplement without mortality, which is contrary to the present study, as the author reported non-significant ($p < 0.05$) difference among the treatments. Poor performance of weight gain and FCR in the present study could be attributed to the presence of some anti-nutritional factors (Skerman et al., 1988; D'Mello, 1995) which resulted to

poor feed digestibility and utilization (D'Mello, 1992). Feed and water intakes increased significantly ($P < 0.05$) with dietary inclusion of CLM. Total feed intake in this study (1622.40 - 1759.54g/ bird) is in harmony with the report of Nworgu & Fapohunda (2002), but lower (1003 - 1004g/bird) than that reports of Ayanwale (1999). Daily water intake and feed water ratio are similar with the results of Oluyemi & Roberts (2000).

Higher feed intake attributed to higher fiber content of the CLM as the birds eat to satisfy their energy level (Onifade, 1993). The cost of feed per kilograms live weight gain (CFPKLWG) was best in control (N91.86/kg), while on the broiler chicks fed 9.0 - 12.0% CLM supplement, it was N107.59 - N108.57/kg. The CFPKLWG reported here is in agreement with the observation of Nworgu et al. (2005) (N99.31 - N129.49/kg). No mortality was recorded, hence

broiler chicks can tolerate up to 12% (120g/kg) CLM, although maximum dietary inclusion of CLM for optimal performance of broiler chicks should not exceed 3.0% (table 4).

Inclusion of CLM at 12% (120g/kg) reduced cost of one kilogram of formulated feed by N4.0 over the control, although the reduction could not be justified in terms of profit and cost of feed per kilogram live weight gain. The birds fed on CLM free diet had net profit of ₦4.11/ per bird, while those placed on 3 and 6% CLM had ₦2.66 and ₦0.84 profit per bird, unlike the broiler chicks fed 9.0 – 12.0% CLM which resulted to average loss of ₦20.39/bird due to depressed body weight. The profit levels reported here were lower than those reported by Nworgu et al., (1999), Ogundipe (1998) and Nworgu (2007).

Gross ratio was best (0.98:1) for the birds placed on control diet and for every 98 kobo spent the farmer gets ₦1.00 unlike the birds placed on 9.0-12.0% CLM, where a farmer had a loss of ₦0.12 - ₦0.34 for every ₦1.00 spent. The significance of this study is that CLM should not be included in the diet of broiler chicks at more than 3% as inclusion of more than 3% resulted to negative growth rate and negative profit margins unlike the result of some authors.

Conclusion

Three percent dietary inclusion of CLM is adequate for broiler chicks, although it was not significantly ($P>0.05$) different from control. Inclusion of more than 3% CLM in the diets of broiler chicks significantly ($p<0.05$) depressed weight gain and FCR and resulted to negative profit margin. More water should be provided for broiler chicks when fed CLM supplements.

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

References

- Akinsoye OF (1989) Profitability of poultry production in Oranmiyan L.G.A of Oyo State. M. Sc Thesis submitted to Obafemi Awolowo University, Nigeria Pp. 55-57.
- Aletor VA (1986) Some agro-industrial by-products and wastes in livestock feeding; a review of prospects and problems. *World Review of Animal Production* 22: 36-41.
- Aletor VA, Omodara OA (1994) Studies on some leguminous browse plants, with particular reference to their proximate, mineral and some endogenous anti-nutritional constituents. *Animal Feed Science and Technology* 46: 343 - 348. DOI: [http://dx.doi.org/10.1016/0377-8401\(94\)90151-1](http://dx.doi.org/10.1016/0377-8401(94)90151-1).
- AOAC (1990) Association of Official Analytical Chemists. *Official Methods of Analyses*. 15th ed., Washington, D.C.
- Ayanwale BA (1999) Performance and carcass characteristics of broiler chickens feed sodium sesquicarbonate processed soybean diets. *Tropical Journal of Animal Science* 2: 85 - 93.
- D' Mello JPF (1992) Chemical constraints to the use of tropical legumes in animal nutrition. *Animal Feed Science and Technology* 38: 237 - 261. doi: [http://dx.doi.org/10.1016/0377-8401\(92\)90105-F](http://dx.doi.org/10.1016/0377-8401(92)90105-F).
- D' Mello JPF, Acamovic T, Walker AG (1987) Evaluation of *Leucaena* leaf meal for broiler growth and pigmentation. *Tropical Agriculture (Trinidad)* 64: 33-35.
- Daghir NJ (1995) Feed stuffs used in hot regions. In: Daghir NJ (Ed.) *Poultry production in hot climates*, 1st edition. AB International Wallingford UK, Pp. 125-154.
- D'Mello JPF (1995) Leguminous leaf meals in non-ruminant nutrition. In: D'Mello JPF & Devendra C (Eds.) *Tropical Legumes in Animal Nutrition*. CAB International, Wallingford, UK. Pp. 247 -280.
- Donkoh A, Atuahene CC, Poku-Prempeh YB, Twinn IG (1999) The nutritive value of chaya leaf meal (*Cnidoscolus aconitifolius* (Mill.) Johnston): studies with broiler chickens. *Animal Feed Science and Technology* 77: 163 - 172. doi:10.1016/S0377-8401(98)00231-4.
- Esonu BD, Iheukwumere FC, Iwuji TC, Akanu N, Nwugo OH (2003) Evaluation of *Microdesmis puberula* leaf meal as feed ingredient in broiler starter diets. *Nigerian Journal of Animal Production* 30: 3 - 8. doi: <http://dx.doi.org/10.4314/njap.v30i1.3306>.
- Esonu, BO, Emenalom OO, Udedibie ABI, Herbert U, Ekpok CF, Okoli IC, Iheukwumere FC (2001) Performance and blood chemistry of weaner pigs fed raw *Mucuna* beans (Velvet bean) meal. *Tropical Animal Production Investigation* 4:49-54.
- Fragos IM, Ramos N, Venerco M, Martinez RO, Sistach M (1993) *Amaranthus* forage in diets for broiler. *Cuban Journal Agricultural Science* 27: 193 - 198.
- Madubuike FN (1992) Bridging the animal protein gap for rural development in Nigeria: The potential for pig. *Journal of Agriculture and Rural Development* 5: 5-12.
- Ngodigha EM (1994) Incorporation of *Centrosema pubescens* in broilers diets: Effect on performance characteristics. *Bulletin of Animal Health and Production in Africa* 42: 159 - 161.
- NRC (1994) Nutritional Research Council. *Nutritional Requirements of Poultry*. 9th Rev. ed. National Academic Press Washington DC, USA
- Nwajiuba CU (1998) Prospects of improved profitability in the poultry industry in Nigeria. In: Ologhobo AD; Iyayi EA

- (Eds.) The Nigerian livestock industry in the 21st Century 18:20
- Nworgu FC (2004) Utilization of forage meal supplements in broiler production. Ph. D Thesis submitted to University of Ibadan, Ibadan – Nigeria Pp. 136 - 146.
- Nworgu FC (2007) Economic importance and growth rate of broiler chickens served fluted pumpkin (*Telfaria occidentalis*) leaves extract. African Journal of Biotechnology 6: 167-174.
- Nworgu FC, Adebawale EA, Oredein OA, Oni A (1999) Prospect and economics of broiler production using two plants protein sources: Nigerian Journal of Animal Science 2: 159 - 166.
- Nworgu FC, Ajayi FT (2005) Biomass, dry matter yield, proximate and mineral composition of forage legumes grown as early dry season feeds. Livestock Research for Rural Development 17: Article #121. Retrieved July 6, 2015, from <http://www.lrrd.org/lrrd17/11/nwor17121.htm>.
- Nworgu FC, Egbunike GN, Osayomi OJ (2001) Performance of growing rabbits fed a mixture of leaf meals and concentrate. Tropical Journal of Animal Production and Investigation 4: 34 -48.
- Nworgu FC, Egbunike GN, Ogundola FI (2000) Performance and nitrogen utilization of broiler chicks fed full fat extruded soybean meal and full fat soybean. Tropical Animal Production Investigation 3: 47-54.
- Nworgu FC, Fapohunda JB (2002) Performance of broiler chicks fed mimosa (*Mimosa invisa*) leaf meal supplements. *Proceeding of 27th Annual Conference of Nigerian Society for Animal Production (NSAP)* held at Federal University of Technology Akure on March 17th - 21st, 2002 Pp. 128 - 131.
- Nworgu FC, Oduola OA, Alikwe PC, Ojo SJ (2012) Effect of basil (*Ocimum gratissimum*) leaf supplement on initiation of egg laying and egg quality parameters of growing pullets. Journal of food, Agriculture and Environment 10: 337-342.
- Nworgu FC, Olatubosun LO, Egbunike GN, Ajayi IO (2005) Effects of Pueraria (*Pueraria phaseoloides*) leaf meal supplements on the performance of broiler chicks. *Proceeding of 8th Annual Conference of Animal Science Association of Nigeria (ASAN)* held at University of Ado-Ekiti Nigeria on the 12 – 15th September, 2005 Pp 148 -151.
- Obi IU (1990) Statistical methods of detecting differences between treatment means 2^{ed}. Snap Press, Enugu – Nigeria.
- Odunsi AA (2003) Assessment of Lablab (*Lablab purpureus*) Leaf Meal as a Feed Ingredient and Yolk Colouring Agent in the Diet of Layers. International Journal of Poultry Science 2: 71 –74.
- Odunsi AA, Farinu GO, Akinola JO, Togun VA (1999) Growth, carcass characteristics and body composition of broiler chicken fed with sunflower (*Tithonia diversifolia*) forage meal. Tropical Animal Production Investigation 2: 205-211.
- Ogbonna JU, Oredein AO (1998) Growth Performance of Cockerel Chicks Fed *Cassava* Leaf Meal. Nigerian Journal of Animal Production 25: 129-133.
- Ogundipe SO (1998) Poultry production modules for family economic advancement programme. An invited paper presented at the silver Anniversary Conference of Nigerian Society of Animal Production (NSAP) at Gateway Hotel Abeokuta on the 21st – 26th March, 1998 Pp. 1-10.
- Oluyemi IA, Roberts FA (2000) Poultry production in warm wet climate 2nd revised ed. Spectrum Books Ltd. Ibadan – Nigeria Pp. 93 - 96.
- Omeje SI, Odo BI, Eguw PO (1997) The effects of *Centrosema pubescens* as leaf meal concentrate for broiler birds. *Proceeding of 22nd Annual Conference of NSAP* held at Abubakar Tafawa Balewa University, Bauchi – Nigeria Pp 136 - 137.
- Onifade AA (1993) Comparative utilization of three dietary fibres in broiler chickens. Ph. D thesis submitted to University of Ibadan, Ibadan – Nigeria Pp. 105 - 110.
- Opara CC (1996) Studies on the use of *Alcornia cordifolia* leaf meal as feed ingredient in poultry diets. M.Sc. Thesis submitted to Federal University of Technology, Owerri, Nigeria: 115 - 118.
- Pauzenga U (1985) Feeding paneat stock. Zootechnical International 5: 22-23.
- Peiretti PG (2005) Prediction of the gross energy of Mediterranean forages. Journal of Food, Agriculture and Environment 3: 102 - 104.
- Raharjo YC, Cheeke PR, Patton NM, Supriyati K (1986) Evaluation of tropical forage and by-product production. I. Nutrient digestibility and effect of heat treatment. Journal of Applied Rabbit Research 9: 56 - 66.
- Skerman PI, Cameroon DG, Riveros F (1988) *Centrosema* spp. In: Skerman PJ (Ed.) *Tropical Forage Legumes* 2nd ed. FAO Plant Production and Protection Series, No.2. Rome Italy Pp. 237 - 257.
- Thackie AM, Flenscher JE (1995) Nutritive value of wild sorghum fortified with leucaena (*Leucaena leucocephala* Wh. Lam.) Bulletin Animal Health, Africa 43:223-275.
- Topps JH (1992) Potential composition and use of legume shrubs and trees as fodder for livestock in the tropics. The

Journal of Agricultural Science 118: 1-8. doi: <http://dx.doi.org/10.1017/S0021859600067940>.

Udedibie ABI, Igwe FO (1989) Dry matter yield and chemical composition of pigeon pea (*C. cajan*) leaf meal and the nutritive value of pigeon pea leaf meal and grain meal for laying hens. *Animal Feed Science and Technology* 24: 111-119. doi:10.1016/0377-8401(89)90024-2.

WAC (2006) World Agroforestry Centre. Spreading the word about leaf meal. Spore 125:6.

WBTP (1983) World Bank Technical Paper. Apprising poultry enterprises for profitability. A manual for potential investors Number 10, Washington DC., USA Pp. 1-200

Wilson ASB, Lansbury TY (1958) *Centrosema pubesens*. Ground cover and forage crop in cleared rainforest of Ghana. *Empire Journal of Experimental Agriculture* 26: 351 - 364.