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Effects of Dietary Protein Level at Early Growth Stage on Growth Performance and Carcass Characteristics of Cameroonian Indigenous Barred Chickens

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Original Research Article

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Abstract: This study was designed to determine the protein needs of Cameroonian indigenous barred chickens at the early stage of growth. At the starter phase (1 to 12 weeks), the experimental rations consisted of 20% (R20), 18% (R18) and 16% (R16), while at the grower phase (13 to 20 weeks), it consisted of 18% (T18), 16% (T16) and 14% (T14) protein levels. Data were recorded on feed intake, weight gain, and feed conversion ratio and carcass traits. Results revealed that weight gain significantly increased with the increasing level of dietary protein at the starter phase. The highest feed conversion ratio (4.6) was recorded with the lowest protein level (16%) while the lowest (3.92) was obtained with the highest protein level (20%). At the grower phase, increasing dietary protein level induced a significant drop in weight gain in pullets while the opposite trend was recorded in cockerels. The smallest feed conversion ratio was recorded with 18% protein which was otherwise not statistically different ($p>0.05$) from the result recorded with 16% protein. No significant effect of graded level of dietary protein was recorded on carcass traits. However, in pullets abdominal fat deposit increased in linear manner with the increasing protein content of the ration while the reverse trend was observed in cockerels which recorded the more developed thighs. In conclusion, at the starter phase, 20% dietary protein are needed for a better growth performance while at the grower phase, 16 and 18% dietary protein are required for a better growth rates of Cameroonian barred pullets and cockerels respectively.
Keywords: Growth performance, indigenous chicken, barred chickens, protein needs.

INTRODUCTION

In sub-Saharan Africa, indigenous chicken is an important sector for food security, poverty alleviation and economic development of deprived groups. However, despite its multiple advantages, local breed chickens expresses very low productivity compared to commercial strains broilers and layers [1-3]. Several authors believe that the production performance of these birds can improve if they are subjected to improved breeding conditions [4-7]. Indeed, indigenous chickens breeding faced several constraints among which adequate food remains the major challenge [8-10]. Many research carried out on local breed concluded that there is a need to use an improved and balanced diets to increase and maximize the productivity and profitability of local chicken farming. This is only possible if the specific needs of the animal are initially known [11-13].

In poultry nutrition, protein is one of the most significant components as far as cost of production is concerned. Protein sources constitute a major factor on economic performance in poultry farms [14-16]. Insufficient levels of proteins in the diet reduce performances, while excess leads to increased nitrogen excretion in the urine and faeces, contributing to environmental pollution [17]. The results obtained from the assessment of nutritional needs in the village chicken vary from one study to another and from one country to another suggesting a great variability of the genetic material within the populations of these hens [18, 19]. In Cameroon, a recent study designed to determine the energy needs of local barred chicken by Mube *et al.* [20] adopted 2800 kcal/kg as metabolisable energy requirement of this chicken at early growth period. However, there is no information about its protein requirements. This study was therefore designed to determine the level of protein necessary to optimize the growth performance of Cameroon's barred chicken.

MATERIALS AND METHODS

Study site

This study was carried out at the Poultry Research Unit of the Teaching and Research Farm of the Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon (LN 5 to 7°, LE 8 to 12°). Dschang is a mountainous area located in the western region of Cameroon at 1420 m above sea level with an average rainfall of 2000 mm.

Animal and experimental rations

At the starter phase, experimental birds consisted of 180 unsexed day-old barred chicks obtained from artificial incubation of eggs produced by a stabilized population (F3) of local barred chickens at the Teaching and Research Farm of the University of Dschang, Cameroon. From 1 to 12 weeks, chicks were randomly distributed to 3 dietary groups, with 4 replicates of 15 chicks each in a completely randomized design. Chicks were raised on a littered floor in an open system under artificial heat provided by the used of electric bulbs during the first 14 days.

At the grower phase (13 to 20 weeks), 210 sexed chicks (105 cockerels and 105 pullets) were randomly distributed among the different experimental units in a 3 x 2 factorial design (3 dietaries proteins levels and 2 sexes) with 5 replicates for cockerels (7 cockerels per replicate) and pullets (7 pullets per replicate). During starter and grower phases, feed and water were offered *ad libitum*.

At the starter phase, chicks were vaccinated against Newcastle disease and infectious bronchitis on the 7th day with a booster dose on the 23rd day and against Gumboro disease on the 10th day. Vitamins and an anticoccidian were administered three consecutive days every week at starter phase, while during the grower phase (13 to 20 weeks), anticoccidian and internal parasite cleaner were administered every three weeks.

At starter phase, experimental rations consisted of three isocaloric ration (2800 kcal/kg DM of metabolizable energy) containing 16% (R16), 18% (R18) and 20% (R20) of crude proteins chosen based on the needs of the commercial breeds layers (Table 1). At the grower phase, experimental rations consisted of 14% (T14), 16% (T16) and 18% (T18) of crude proteins with constant metabolizable energy (3000 kcal/kg DM) content (Table 2).

Table-1: Composition and chemical characteristics of experimental rations at the starter phase

Ingredients (kg)	Experimental rations		
	R20 (20%)	R18 (18%)	R16 (16%)
Maize	55.6	58.8	61.85
Wheat bran	15.65	20.35	21.45
Cotton seed meal	6.75	3	2.2
Soybean meal	13.25	7	4.7
Fish meal	2.5	5	3.5
Borne meal	0.5	0	0
Oeister shell	0.75	0.75	1
Premix(*)	5	5	5
Lysine	0	0.1	0.25
Methionine	0	0	0.05
Total	100	100	100
Calculated chemical composition			
Crude protein (%)	20.01	18.02	16.02
Metabolizable energy (kcal/kg)	2 800.30	2 800.85	2 800.80
Calcium (%)	1.06	1.07	1.06
Phosphorous (%)	0.56	0.59	0.53
Lysine (%)	1.08	1.08	1.03
Methionine (%)	0.40	0.40	0.41
Energy/Protein	139.95	155.43	174.83

*Premix: Crude protein=40%, Lysine = 3.3%, Methionine = 2.4%, Calcium= 8%, Phosphorous=2.05%, Metabolizable energy = 2078 kcal/kg

R20=Ration containing 20% of crude proteins, R18=Ration containing 18% of crude proteins, R16=Ration containing 16% of crude proteins

Growth performances and carcass characteristics

Feed intake (FI) and live body weight (BW) for individual chick were recorded weekly. Body weight gain (BWG) was obtained by the difference in BW of two consecutive weeks. Feed conversion ratio (FCR) was obtained by dividing the weekly FI by weekly BWG.

At the end of the experiment at 20 weeks, 15 cockerels and 15 pullets per treatment (3 chickens per replicate) were randomly selected and fasted for 24-hour for carcass evaluation as described by Mube [20]. The relative weight of gizzard, liver, heart, head, wings, and legs was calculated and expressed in percentage of live body weight. The length of the intestine was measured from the duodenal loop to the cloaca using a tape measure and the density of the intestine was calculated by dividing the weight of the intestine/length of the intestine.

Table-2: Composition and chemical characteristics of experimental rations at the grower phase

Ingredients (kg)	Experimental rations		
	T18 (18%)	T16 (16%)	T14 (14%)
Maize	68.15	71.5	74.325
Wheat bran	8.35	10.075	11.3
Cotton seed meal	4	2	3
Soybean meal	11.5	8	3.5
Fish meal	2.5	2.5	1.5
Borne meal	0	0.25	0.25
Oeister shell	0.5	0.5	0.75
Premix 5% (*)	5	5	5
Lysine	0	0.125	0.3
Methionine	0	0.05	0.075
Total	100	100	100
Calculated chemical composition			
Crude protein (%)	18.01	16.03	14.01
Metabolizable energy (kcal/kg)	3 005.00	3 007.28	3 005.70
Calcium (%)	0.81	0.87	0.89
Phosphorous (%)	0.38	0.41	0.38
Lysine (%)	0.97	0.96	0.97
Methionine (%)	0.38	0.40	0.40
Energy/Protein	166.85	187.60	214.54

*Premix: Crude proteins = 40%, Lysine =3.3%, Methionine = 2.4%, Ca = 8%, P=2.05%, Metabolizable energy=2078 kcal/kg

T18=Ration containing 18% of crude proteins, T16= Ration containing 16% of crude proteins, T14= Ration containing 14% of crude proteins

STATISTICAL ANALYSIS

Data recorded on feed intake, live body weight, feed conversion ratio and carcass characteristics were submitted to analysis of variance (ANOVA) by General Linear Model procedure of Statistical Package for Social Sciences software (SPSS 20.0). The difference were tested using a Duncan's Multiple Range's test and probability values less than 0.05 were considered as significant.

RESULTS

Table 3 summarizes growth performance of Cameroonian barred chickens fed on graded levels of proteins at the starter phase. Feed intake was not significantly affected by the proteins level of the rations. Live body weight and weight gain significantly ($p<0.05$) increased while feed conversion ratio decreased in a linear manner with the increasing level of proteins of the ration.

Table-3: Effects of protein levels of the ration on growth performance of local barred chicks from day 1 to 12 weeks old

Growth parameters	Experimental rations			*P-value*
	R16 (16%)	R18 (18%)	R20 (20%)	
Feed intake	3673±193.09	3347.55±335.47	3514.74±236.60	0.263
Live body weight at 12 weeks (g)	850.00±43.84^{a}	871.18±58.05^{a}	956.28±22.45^{b}	0.018
Body weight gain (g)	818.08±42.49^{a}	840.80±59.11^{a}	925.52±21.91^{b}	0.017
Feed conversion ratio	4.60±0.28^{b}	4.01±0.29^{a}	3.92±0.48^{a}	0.051

$^{a, b}$: averages with different superscripts on the same line are significantly (P <0.05) different.

The growth profiles of chickens were similar in all groups. However, live body weight of chicks fed on ration containing the highest protein level (20%) was above the weight of chicks fed on rations containing 18 and 16% of proteins from week 4 to 12 weeks old (figure 1).

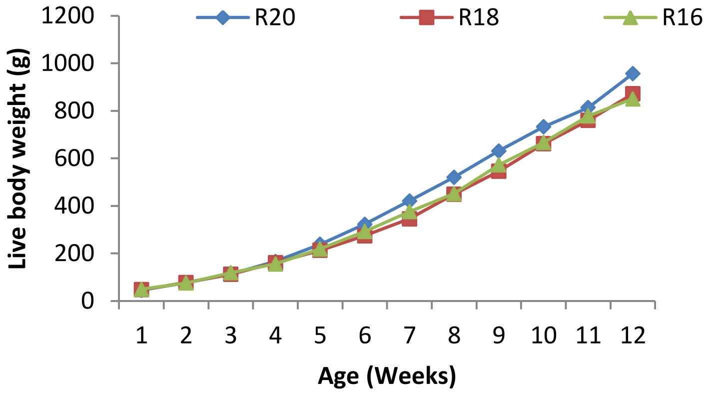

Fig-1: Weekly evolution of live body weight of local barred chicks as affected by dietary protein levels from day 1 to 12 weeks

As summarized in table 4, increasing protein content of the ration from 14 to 18% has no significant effect on feed intake and live body weight of local barred cockerels and pullets from 13 to 20 weeks old. However, cockerels consumed more feed than pullets whatever the protein level of the ration. The increasing level of dietary protein significantly increased cockerels' weight gain while above 16% protein the reverse trend was recorded in pullets. In both cockerels and pullets, feed conversion ration significantly decreased with the increasing protein content of the ration.

Table-4: Growth performance of local barred chickens as affected by the graded levels of proteins from 13 to 20 weeks old

Growth parameters	Experimental rations			*P-value*
	T14 (14%)	T16 (16%)	T18 (18%)	
Feed intake (g)				
Pullet	3771.73±90.01	4188.28±360.06	3720.25±1018.38	0.455
Cockerel	5665.12±467.50	5066.28±513.33	5178.01±937.43	0.359
Pullet and cockerel	4719.42±1047.16	4627.28±623.59	4449.12±1200.75	0.826
Live body weight (g)				
Pullet	1308.71±81.43	1367.00±81.30	1326.01±63.74	0.482
Cockerel	1675.02±151.42	1713.32±90.93	1733.31±114.87	0.749
Pullet and cockerel	1525.23±252.34	1594.52±252.69	1583.22±284.13	0.821
Body weight gain (g)				
Pullet	755.59±72.00[a]	587.03±46.67[b]	533.42±42.53[b]	0.000
Cockerel	500.27±73.73[b]	849.14±62.37[a]	919.41±96.75[a]	0.000
Pullet and cockerel	627.93±151.09	718.09±147.58	726.41±215.29	0.387
Feed conversion ratio				
Pullet	8.33±1.15[a]	7.66±0.97[ab]	6.54±0.47[b]	0.028
Cockerel	8.69±0.77[a]	6.37±0.42[b]	6.31±0.68[b]	0.000
Pullet and cockerel	8.51±0.94[a]	7.02±0.98[b]	6.43±0.57[b]	0.000

[a, b]: Means with the same superscript in the same line are not significantly different (P> 0.05)

Digestive organs

The development of the digestive organs of local barred chickens as affected by the protein content of the ration is summarized in Table 5. Irrespective to the protein level and the sex of chickens, no significant difference was recorded between the different treatments for all the studied digestive organs. However, although not significant the increase in protein level of the diet decreases the length of the intestine irrespective of sex.

Table 6 summarizes the carcass characteristics of the barred chicken as affected by the protein level of the ration at twenty weeks old. No significant differences were found between the treatment groups for carcass traits regardless of the level of protein in the diet. However, abdominal fat deposit is more important in pullets than cockerels irrespective to the protein level. In pullets, abdominal fat increased in linear manner with the increasing protein content of the ration while the reverse trends was noticed in cockerels which recorded the more developed thighs.

Table-5: Effects the graded levels of proteins on digestive organs development from 13 to 20 weeks old

Digestive organs	Sex	Experimental rations			*P-value*
		T14 (14%)	T16 (16%)	T18 (18%)	
Gizzard (% BW)	♀	2.02±0.33	1.86±0.22	1.92±0.13	0.580
	♂	1.84±0.34	1.72±0.35	1.62±0.24	0.558
	♂♀	1.93±0.33	1.79±0.28	1.77±0.24	0.411
Intestine weight (g)	♀	29.60±4.40	33.64±7.92	32.82±8.08	0.640
	♂	37.14±5.28	34.96±10.63	28.82±5.23	0.231
	♂♀	33.37±6.06	34.30±8.86	30.82±6.75	0.553
Intestine length (cm)	♀	107.10±11.66	105.28±11.88	102.52±7.50	0.791
	♂	117.32±14.67	112.12±11.25	108.98±2.09	0.485
	♂♀	112.21±13.60	108.70±11.49	105.75±6.20	0.425
Intestine density (g /cm)	♀	0.30±0.01	0.32±0.08	0.34±0.09	0.679
	♂	0.32±0.04	0.32±0.08	0.24±0.05	0.110
	♂♀	0.31±0.03	0.32±0.08	0.29±0.09	0.630

Table-6: Carcass traits of local barred chickens as affected by graded proteins content of the ration

Carcass traits (% BW)	Sex	Experimental rations			*P-value*
		T14 (14%)	T16 (16%)	T18 (18%)	
Carcass yield	♀	71.29±5.72	68.10±0.91	68.11±0.91	0.329
	♂	69.03±1.63	68.40±4.17	71.31±4.82	0.467
	♂♀	70.16±4.09	68.25±3.36	69.72±3.68	0.500
Liver	♀	1.57±0.13	1.55±0.34	1.62±0.19	0.898
	♂	1.46±0.059	1.39±0.14	1.39±0.14	0.295
	♂♀	1.51±0.11	1.46±0.28	1.50±0.20	0.813
Heart	♀	0.45±0.06	0.48±0.08	0.52±0.05	0.258
	♂	0.58±0.04	0.49±0.04	0.54±0.05	0.039
	♂♀	0.52±0.08	0.49±0.06	0.53±0.05	0.405
Abdominal fat	♀	3.80±1.65	4.00±1.09	4.48±0.64	0.666
	♂	2.40±0.84	1.83±0.88	1.75±0.74	0.410
	♂♀	3.10±1.47	2.91±1.47	3.11±1.58	0.944
Head	♀	2.64±0.23	2.62±0.23	2.59±0.10	0.921
	♂	3.03±0.10	3.10±0.18	2.88±0.42	0.432
	♂♀	2.8±0.27A	2.86±0.32	2.73±0.33	0.612
Legs	♀	2.79±0.35	2.63±0.09	2.57±0.11	0.274
	♂	3.35±0.21	3.33±0.25	3.42±0.27	0.850
	♂♀	3.07±0.39	2.98±0.41	2.99±0.49	0.885
Thighs	♀	20.68±0.66	20.28±0.41	19.93±0.50	0.128
	♂	22.78±1.30	22.84±0.58	23.06±0.29	0.858
	♂♀	21.73±1.47	21.56±1.42	21.50±1.69	0.941
Wings	♀	8.58±0.33	8.89±0.54	8.67±0.15	0.886
	♂	8.55±0.41	8.83±0.63	8.87±0.49	0.588
	♂♀	8.56±0.44	8.86±0.55	8.77±0.36	0.309

DISCUSSION

At the starter phase (1 to 12 weeks), the increasing level of crude protein of the ration did not significantly affect feed intake. This would probably be related to the balance of energy/protein ratio that was constant in the experimental rations. This result is in line with the findings of Elangovan *et al.* [21] who reported that in a constant energy content diets, the variation of the protein content from 16 to 22% (16, 18, 20 and 22%) did not alter feed intake in the cross-breed (*necked-neck X Red Cari*) chicks. Similar results with different levels of proteins at starter phase have also been reported by several other authors [22-24]. The highest feed conversion ratio (4.6) was recorded with the lowest protein level (16%) while the lowest (3.92) was obtained with the highest protein level (20%). A similar conclusion was drawn by Panda *et al.* [25] in *Vanaraja* chicks and this conclusion is in agreement with Nguyen and Bunchasak [26] and Rajpura *et al.* [27] who conducted similar trials on *Betong* hen and commercial hens respectively. The results obtained by Sklan and Plavnik [28] and Kamran *et al.* [29] agree with those in the present study that the level of protein in the diet significantly ($p<0.05$) affects body weight and weight gain and higher levels induce the best growth performances of chickens at the starter phase.

This observation clearly indicates the positive effect of high protein levels on chick weight during the early stage of growth [30].

At the grower phase, feed intake and body weight of barred hens were not significantly affected ($p > 0.05$) by the dietary protein level. A similar observation was made by Miah *et al*. [31] in *Desi* village chicken. The present observations corroborate the findings of Sankande [32] who claims that dietary protein levels are not a factor influencing feed intake because chickens consume more to satisfy their energy needs than protein. The highest feed conversion ratio ($P<0.05$) was recorded with the lowest protein level (14%) and the difference between the two other diets (16 and 18%) was not significant ($p>0.05$). This may be due to the low concentration or imbalance of amino acids in the ration containing 14% protein compared to the other two diets. In agreement with the present results, Pfeffer *et al*. [33] reported that broiler chicks fed on diet containing 15.3% protein recorded the highest feed conversion ratio. Contrary to the present study, Buakeeree and Nualhnuplong [34] reported a non-significant change in feed conversion ratio of *Betong* pullets fed on graded protein levels. The average feed conversion ratio noted in this work tends to increase with age. In fact, the highest feed conversion ratio recorded with the smallest protein content can be justified by the small weight gain recorded with the same protein level and thus highlight the decrease in the bird's ability to convert low protein feed [35].

The live weight induced by 16% of crude protein in pullets was relatively higher than that of hens subjected to other diets indicating a better assimilation of the feed with this level of protein which would be optimal for pullets. Consequently the low weight gain recorded with the 18% is the consequence of excess of protein for this chicken at the grower phase. The present result is consistent with the findings of Mohanty *et al*. [36] who reported that 16% protein is optimal in the *Khaki Campbell* duck diet between 9 and 16 weeks old. Indeed, increasing the protein content of the feed beyond a certain threshold in animals with a specific development phase would not improve protein accumulation but could rather have deleterious effects on protein synthesis [37] by inducing changes in the hormonal balance of animals [38].

As reported in this study, Folorunso and Onibi [23] and Magala *et al*. [39] revealed that there is no significant change in carcass yield in Ugandan village and broiler chickens respectively when protein levels in the diet ranged from 18 to 21%. The reason why the carcass did not change under the effect of the protein level of the diet could be that the lowest protein level tested was sufficient to induce the synthesis of the non-essential amino acids necessary for the constitution of the carcass [40].

The results obtained by Si *et al*. [41] in broilers and Nguyen and Bunichasak [26] in *Betong* hen are not in agreement with the present results. The latter reported that the increase in protein content induced a decrease in the proportion of abdominal fat. This variation could be attributed to the age and genetic type of hens. The abdominal fat deposits reported in this study are close to those recorded by Molee *et al*. [42] with 16% protein at 16 weeks old in the Thailand village chicken.

Whatever the sex, the treatments were comparables for the proportions of the breast weight thus corroborating the findings of Tarasewicz *et al.* [43] who reported that diets with low levels of protein do not significantly affect the carcass traits of chickens. These results are however opposed to the observations of Corrêal *et al*. [44] who reported that carcass yield increases significantly with the increasing level of protein in the ration of female quail.

CONCLUSION

The results presented in this study indicate that at starter phase (1 to 12 weeks), 20% protein would be needed for an optimal feed conversion ratio and body weight gain. Otherwise, at the grower phase (13 to 20 weeks), 16 and 18% proteins are required for a better growth rates of Cameroonian barred pullets and cockerels respectively.

REFERENCES

1. Sonaiya F. Smallholder family poultry as a tool to initiate rural development. InInternational Conference Poultry in the Twenty-first Century: avian influenza and beyond: 5–7 November 2007 2007 Nov 5.
2. Keambou TC, Mboumba S, Touko BA, Bembide C, Mezui TM, Tedongmo AM, Manjeli Y. Growth performances, carcass and egg charac-teristics of the local chicken and its first generation reciprocal crossbreds with an exotic strain in Cameroon. Adv. Anim. Vet. Sci. 2015;3(10):507-13.
3. Wong JT, de Bruyn J, Bagnol B, Grieve H, Li M, Pym R, Alders RG. Small-scale poultry and food security in resource-poor settings: A review. Global Food Security. 2017 May 2.
4. Mutayoba SK, Katule AK, Minga U, Mtambo MM, Olsen JE. Seasonal variation in nutritive value of scavenged feed and effect of supplementation on performance of rural birds. Agric Biol JN Am. 2011;2:1310-6.
5. Faruque S, Islam MS, Afroz MA, Rahman MM. Evaluation of the performance of native chicken and estimation of heritability for body weight. Journal of Bangladesh Academy of Sciences. 2013;37(1):93-101.
6. Ouedraogo B, Bale B, Zoundi SJ, Sawadogo L. Caractéristiques de l'aviculture villageoise et influence des techniques d'amélioration sur ses performances zootechniques dans la province du

Sourou, région Nord-Ouest Burkinabè. International Journal of Biological and Chemical Sciences. 2015;9(3):1528-43.
7. Nahimana G, Missohou A, Ayssiwede SB, Cissé P, Butore J, Touré A. Amélioration de la survie des poussins et des performances zootechniques de la poule locale en condition villageoise au Sénégal. Revue d'élevage et de médecine vétérinaire des pays tropicaux. 2017 Sep 20;70(1):3-8.
8. Moula N, Antoine-Moussiaux N, Farnir F, Detilleux J, Leroy P. Réhabilitation socio-économique d'une poule locale en voie d'extinction: la poule Kabyle (Thayazit lekvayel). InAnnales de Médecine Vétérinaire 2009 (Vol. 153, pp. 178-186). Université de Liège.
9. Glatz PC. L'aviculture durable à petite échelle: les aliments locaux pour animaux sont-ils une option viable pour la région du Pacifique?.
10. SB A, Dieng A, MRB H, CAAM C. Élevage des poulets traditionnels ou indigènes au Sénégal et en Afrique Subsaharienne: état des lieux et contraintes. Ann. Méd. Vét. 2013;157:103-19.
11. Momoh OM, Egahi JO, Ogwuche PO, Etim VE. Variation in nutrient composition of crop contents of scavenging local chickens in North Central Nigeria. Agric Biol J North Am. 2010;1:912-5.
12. Ayssiwede SB, Chrysostome CA, Zanmenou JC, Dieng A, Houinato MR, Dahouda M, Akpo Y, Hornick JL, Missohou A. Growth Performances, Carcass and Organs Characteristics and Economics Results of Growing Indigenous Senegal Chickens Fed Diets Containing Various Levels of Leuceana leucocephala (Lam.) Leaves Meal. International Journal of Poultry Science. 2011;10(9):734-49.
13. Hanyani CT. Effect of full and semi-scavenging rearing systems on crop contents and the quality of meat from village chickens during the spring season of Eastern Cape: South Africa.
14. Olugbemi TS, Mutayoba SK and Lekule FP. Effect of Moringa (*Moringa oleifera*) Inclusion in Cassava Based Diets Fed to Broiler Chickens. International Journal of Poultry Science. 2010; 9(4):363-367.
15. Adbalqdadir MO and Arabi SA. The Effects of Different Lysine and Methionine Levels on Broiler Chickens Performance. International Journal of Innovative Agriculture & Biology Research. 2014; 2 (4): 46-52.
16. Perween S, Kumar K, Chandramoni Kumar S, Kumar Singh P, Kumar M and Dey A. Effect of feeding different dietary levels of energy and protein on growth performance and immune status of Vanaraja chicken in the tropic. Veterinary World. 2016; 9 (8): 893–899.
17. Banerjee SA, Melesse E, Dotamo K, Berihun and Beyan M. Effect of Feeding Different Dietary Protein Levels with Iso-Caloric Ration on Nutrients Intake and Growth Performances of Dual-Purpose Koekoeck Chicken Breeds. International Journal of Applied Poultry Research. 2013; 2(2): 27-32.
18. Raach-Moujahed A, Haddad B, Moujahed N and Bouallegue M. Evaluation of growth performances and meat quality of Tunisian local poultry rose in outdoor access. International Journal of Poultry Sciences. 2011; 10 (7): 552-559.
19. 19 Bekalu Walle. Performance Evaluation of Scavenging Local Chicken Under Intensive and Extensive Production System: The Case of Enbsie Sar Middir District East Gojjam. Ethiopia. *M. Sci. Thesis.* Haramaya University. Haramaya. 2017. 73p.
20. Mube KH. Besoins énergétiques et caractéristiques de production de la poule (*Gallus gallus*) Barrée villageoise. Thèse de Doctorat/PhD en Biotechnologie et Productions Animales. Option ; Nutrition et Alimentation Animales. FASA. Université de Dschang. Cameroun. 2016; 150p.
21. Elangovan AY, Deo C, Mandal AB, Singh DP, Shrivastava HP. Protein requirements of growing (12–20 weeks) Naked neck x CARl-Red (Hitcari) and Frizzle x CARI-Red (Upcari) pullets. Indian Journal of Poultry Science. 2004;39(1):61-5.
22. Wolde S, Negesse T, Melesse A. Effect of dietary protein concentration on feed intake, body mass gain and carcass traits of Rhode Island Red chicken. Journal of Science and Development. 2011;1(1):53-64.
23. Folorunso OR and Onibi GE. Effect of Different Protein Levels Fed on Dry or Wet Forms on the Performance and Carcass Characteristics of Broiler Chicken Finishers. International Journal of Agricultural Sciences. 2012; 2 (6). 538-545.
24. Liu SK, Niu ZY, Min YN, Wang ZP, Zhang J, He ZF, Li HL, Sun TT, Liu FZ. Effects of dietary crude protein on the growth performance, carcass characteristics and serum biochemical indexes of Lueyang black-boned chickens from seven to twelve weeks of age. Revista Brasileira de Ciência Avícola. 2015 Mar;17(1):103-8.
25. Panda A, Rama RAO SV, Raju M, Niranjan M, Reddy M. Project Directorate on Poultry News Rajendranagar. 2009.
26. Nguyen TV and Bunchasak. Efects of Dietary Protein and Energy on Growth Performance and Carcass Characteristics of Betong Chicken at Early Growth Stage. Songklanakarin Journal of Science and Technology. 2005; 27(6):1072-1078.
27. Rajpura RM, Savaliya FP, Khanna K and Patel AB. Growth and feed efficiency in colored crossbred broilers reared on different dietary energy and protein levels. Indian Journal of Poultry Science. 2010; 45 (2): 146-149.
28. Sklan D and Plavnik I. Interactions between dietary crude protein and essential amino acid intake on performance in broilers. British Journal of Nutrition. 2002; 43(3):442-449.
29. Kamran Z, Sarwar M, Nisa M, Nadeem MA, Mahmood S, Babars ME and Ahmed S. Effect of Low Protein Diets Having Constant Energy to Protein Ratio on Performance and Carcass

Characteristics of Broiler Chickens from 1-35 Days of Age. Poultry Science. 2008; 87: 468-474.
30. Tandekar. Study of Protein Requirements in Commercial Cockerels. Master Thesis. Nagpur Veterinary College. Nagpur. India. 2012.
31. Miah MY, Chowdhury SD and Bhuiyan AKFH. Effect of diets of different concentrations on indigenous growing chicks of bangladesh in confinement. Asian Journal of Medical and Biological Research. 2015; 1 (1):109-113.
32. Sakande S. Contribution à l'étude de l'influence des apports en protéines alimentaires sur les performances de croissance et le rendement carcasse de la pintade commune (*Numida meleagris*) et du Poulet de chair (*Gallus domesticus*). Thèse de doctorat vétérinaire. Ecole Inter-Etats des Sciences et Médecine Vétérinaires de Dakar-Sénégal. 1993.
33. Pfeffer E, Aletor VA and Hamid II. Low protein amino acid supplemented diets in broiler chickens: effect on performance, carcass characteristics, whole body composition and efficiency of nutrient utilization. Journal of the Science of Food and Agriculture. 2000; 80(5):447-554.
34. Buakeeree K and Nualhnuplong P. Effects of Dietary Protein and Energy Levels on Growth Performances and Reproductive System Development in Female *Betong* Chicken (*Gallus domesticus*) during growing-pullet period. Khon Kaen Agricultural Journal. 2016; 44 (3): 469-478.
35. INRA. L'alimentation des animaux monogastriques : Porcs. lapins. volailles. 2ème Edition. INRA. Paris. 1989; 282 p
36. Mohanty SR, Babu LK, Sahoo SK, Pradhan CR, Panigrahi B and Joshi1 SK. Effect of Feeding Different Levels of Proteins on Growth, Feed Consumption and Mortality in Growing khaki Campbell Duck. Scholars Journal of Agriculture and Veterinary Sciences. 2016; 3(1): 58-61.
37. Tesseraud S. Métabolisme protéique chez le poulet en croissance. Effet des protéines alimentaires. INRA Productions Animales. 1995; 8: 197-212.
38. Kita K, Muramatsu T and Okumura J. Influence of excess protein intake on whole-body protein synthesis in chicks. Nutrition Reports International. 1989; 39: 1091-1097.
39. Magala H, Kugonza DR, Kwizera H and Kyarisiima CC. Influence of Varying Dietary Energy and Protein on Growth and Carcass Characteristics of Ugandan Local Chickens. Journal of Animal Production Advances. 2012; 2 (7): 316-324.
40. Bregendahl K, Sell JL and Zimmerman DR. Effect of low protein diets on growth performance and body composition of broiler chicks. Poultry Science. 2002; 81: 1156-1167.
41. Si J, Fritts CA, Waldroup PW and Burnham DJ. Extent to which crude protein may be reduced in corn-soybean meal broiler diets through amino acid supplementation. International Journal of Poultry Sciences. 2004; *3*: 46-50.
42. Molee W, Puttaraksa P, Pitakwong S and Khempaka S. Performance. Carcass Yield. Hematological Parameters. and Feather Pecking Damage of Thai Indigenous Chickens Raised Indoors or with Outdoor Access. World Academy of Science, Engineering and Technology. 2011; 5(8): 1-4.
43. Tarasewicz Z, Gardzieiewska J, Szczerbinska D, Ligocki M, Jakubowska M and Majewska D. The effect of Feeding with Low-Protein Feed Mixes on The Growth and Slaughter Value of Young Male Pharaoh Quails. Archiv Tierzucht, 2007; *50*: 520-530.
44. Corrêa1 GSS, Silva MA, Corrêa1 AB, Fontes DO, Santos GG and Lima Neto HR. Crude Protein Level for Meat Type Quail during the Growing Period. Arquivo Brasileiro de Medecina Veterinaria e Zootecnia. 2008; 60 (1): 209-217.