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Effects of Energy and Protein Ratios on the Performance of Grower Pullet Chickens in Yola, Adamawa State, Nigeria

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ABSTRACT: *This study was aimed at determining the optimum ratio of energy and protein to promote optimal growth of grower pullet chickens that will give optimum layer performance in terms of egg production, weight, quality and to compare the cost implications of the various energy protein ratios. The following parameters were used: feed intake, bodyweight gain, feed conversion ratio and water intake. Two hundred and seventy (270) grower pullet chickens (Isa Brown), were randomly allocated into nine treatments at 30 birds per treatment. Each treatment was replicated three times in RCBD involving 3×3 factorial arrangement. The grower pullet chickens were fed nine treatment diets containing 3 energy levels (2500, 2700 and 2900 ME (kcal/kg) and 3 crude protein levels (14, 15 and 16%). Feed and water were given ad libitum. Feed intake, body weight gain, feed conversion ratio and water intake of grower pullet chickens were significantly (P<0.05) influenced by energy-protein ratios. Feed intake decreased with increase in energy-protein ratio of the diets. Grower pullets fed diets containing 2500 and 2700 ME (kcal/kg) diet at14% CP recorded low feed intake, body weight gain, water intake and feed cost/kg gain compared to others while those on 2700 ME (kcal/kg) diet at 14% CP showed lower FCR. Based on the results of this study, it was concluded that the body weight of grower pullets was better controlled on 2700 ME (kcal/kg) diet at 14% CP. Hence, it is therefore recommended.*

KEY WORDS: energy, protein, grower pullet, body weight gains, feed intake.

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INTRODUCTION

Nigeria with a population of about 218.5 million people (PRB, 2022) and poultry population of about 180 million (FAO, 2019) with 1.8 kg and 3.5 kg per capita consumption of poultry meat eggs per year respectively (FAO, 2019) will require more of poultry meat and products per annum to meet the basic minimum dietary needs of Nigerians. The poultry industry in Nigeria, is faced with a number of problems such as scarcity of feed, day old chicks; high cost of veterinary drugs, vaccines, equipment; high cost and low quality commercial feeds, the protein and energy contents, are considered to be the costliest aspect of feed for poultry. Nutrition is perhaps the most important consideration in livestock management. Inadequate supply of feeds, nutritionally imbalanced rations, adulterated ingredients or stale feeds are some of the factors responsible for low productivity of livestock in the tropics (Ogundipe *et al.*, 2003). Energy is used for the provision of body heat, maintenance, growth and production (Inaku *et al.*, 2011) while protein is a vital nutrient for poultry. In virtue of its amino acid constituents, protein play a significant role in growth, egg production, immunity, adaptation to the environment and in many other biological functions. Production cost of meat is mainly associated with the need to supply dietary energy and protein. While the importance of energy cannot be over-emphasized, dietary protein are essential for normal growth and reproduction of animal. The cost of protein and energy components used in today's commercial poultry diets make up approximately 90% of total feed cost (Daghiri, 1983). In considering any material as component of feeds, its nutritive values, availability, price and ease of processing should be considered. Many energy and protein sources of both plant and animal origins have been used by researchers with the view of minimizing cost of production and improve or at least maintaining performance. Pond *et al.* (2006) stated that feed accounts for about 60-80% of the total costs of poultry production out of which energy constitute 40-60% and protein 30-40%. Aremu *et al.* (2010) stated that the provisions of energy and protein in the diet account for some 90% of the total cost of the ration. Maximizing the efficiency of energy and protein utilization is important for the reduction of feed cost and maximizing profit with absolute minimum intake of diet. The objectives of this study were to assess the effects of energy protein ratios on feed intake, bodyweight gain and feed conversion ratio in grower pullets and to compare the cost implications of the various energy protein ratios on the performance of growing pullets for optimum performance of layer chicken in terms of egg production, weight and quality.

MATERIALS AND METHODS

Study Location

The research was conducted at the University Poultry Research Farm, Modibbo Adama University Yola, Adamawa State, Nigeria. Yola is Located between latitude $7^0$and 11^0N of the equator and longitude11^0 and 14^0E of the Greenwich Meridian with altitude of

185.9m above sea level and lies within the Northern Guinea Savannah Zone of Nigeria. Maximum temperature in the state reaches 40^0C particularly in April while minimum temperature is 18^0C between December and January. Mean monthly temperature in the state ranges from 26.7^0C in the South to 27.8^0C in the North-eastern part of the state (Adebayo, 1999).

Experimental Animals and Management

Two hundred and seventy (270) grower pullets (Isa Brown) were used for this experiment. Records of feed intake and water intake were taken daily while that of body weights were on weekly basis. Feed conversion ratio and body weight gains were also determined on weekly basis. Vaccination for NDV kamorov was carried out on all the birds at 16^{th} week of age as described by NVRI (Anonymous). The floor was covered with wood shavings at a depth of 3-5 cm. The litter was kept under dry condition throughout the grower period to prevent the buildup of moulds. Adequate feed, clean and fresh water was provided *ad libitum*, for a period of eleven weeks (from 9 – 20 weeks of age).

Treatments and Experimental Design and Feeds Formulation

The grower chickens were allocated to nine treatment groups, replicated three times in RCBD involving 3×3 factorial design. The experimental diets were allocated into nine treatment groups (Table 1). They were made up of three metabolisable energy levels (2500, 2700 and 2900) kcal/kg diets respectively with three crude protein levels (14,15 and 16% respectively). Each group was fed iso energy diet at different protein levels (14, 15 and 16% CP) respectively. Three energy levels and three protein levels were used to produce nine treatment diets as explained in Table 1. The experimental diets for the grower pullets were formulated using maize, maize bran, groundnut cake, fish meal, bone meal, limestone, lysine, methionine, salt and premix. The ingredients composition of the experimental grower pullet diets is presented in Table 1.

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Table 1: Ingredients Composition of Experimental Grower Pullet Chickens Diets

	Metabolisable Energy (kcal /kg Diet)								
	2500			2700			2900		
%CP	14 (LELP)	15 (LEMP)	16 (LEHP)	14 (MELP)	15 (MEMP)	16 (MEHP)	14 (HELP)	15 (HEMP)	16 (HEHP)
Ingredients (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8	Diet 9
Maize	10.00	10.00	10.00	31.20	31.20	31.20	52.00	51.00	51.00
Maize Offal	76.00	73.00	70.00	54.85	51.85	48.85	33.55	32.00	29.25
Groundnut Cake	9.30	12.05	15.05	8.00	11.00	14.00	8.00	10.55	12.80
Fish Meal	0.75	1.00	1.00	2.00	2.00	2.00	2.50	2.50	3.00
Bone Meal	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
Lysine	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated Analysis (%)									
Energy (kcal/kg diet)	2510.37	2515.12	2519.32	2711.06	2715.26	2719.46	2906.78	2901.36	2906.31
Crude Protein	14.04	15.10	16.12	14.05	15.07	16.09	14.04	15.00	16.06
Crude Fibre	8.66	8.48	8.31	6.30	6.63	6.47	4.99	4.94	4.76
Ether Extract	2.28	2.41	2.54	2.75	2.88	3.01	3.24	3.32	3.45
Lysine	0.69	0.75	0.80	0.78	0.83	0.89	0.86	0.90	0.96
Methionine	0.33	0.34	0.36	0.39	0.40	0.42	0.45	0.45	0.47
Energy:Protein Ratio	178.80	166.56	156.29	192.96	180.18	169.02	207.36	193.42	181.30
Determined Analysis (%)									
Moisture	6.00	6.00	6.05	6.00	8.00	7.33	7.33	7.03	7.33
Crude Protein	14.30	15.83	16.87	14.21	15.40	16.23	14.95	15.88	16.88
Crude Fibre	10.80	10.00	9.25	8.50	8.00	7.45	5.90	5.52	5.00
Ether Extract	2.30	3.00	3.50	3.50	4.00	4.45	4.70	5.00	5.50
Ash	10.00	6.70	8.35	11.65	8.35	8.35	6.70	10.00	8.35

*Premix manufactured by Bio-Mix, supplying the following per 2.5kg: vitamin A,10,000,000.00IU; Vitamin D,1,800,000.00IU; Vitamin E, 12,000.00IU; Vitamin K,2,200.00mg; Vitamin B1, 2,200.00mg; Vitamin B2, 5,000.00mg, Vitamin B6, 2,500.00mg, Vitamin B12, 10.00 mg; Biotin, 250.00mg; Niacin, 20,000.00mg; Pantothenic Acid, 6,000.00mg; Folic Acid, 800.00mg; Choline Chloride, 210,000.00mg; Manganese,100,000.00mg;Zinc,50,000.00mg;Iron,30,3000.00mg;Copper,10,000.00mg:Iodine,1,500.00 mg; Selenium,250.00mg; Cobalt,250.00mg; Antioxidant,2,000.00mg.

LELP = Low Energy-Low Protein, LEMP = Low Energy-Medium Protein, LEHP = Low Energy-High Protein, MELP = Medium Energy-Low Protein, MEMP = Medium Energy-Medium Protein, MEHP = Medium Energy-High Protein, HELP = High Energy-Low Protein, HEMP = High Energy-Medium Protein, HEHP = High Energy-High Protein

Measurements
The parameters measured were: feed intake, bodyweight, bodyweight gain, water intake and feed conversion ratio. The cost implication of the nine different energy-protein ratio diets were also determined for the experimental birds.

Chemical Analysis
Proximate analysis for dry matter, moisture, crude protein, crude fibre, ether extract, ash and nitrogen free extract of the grower chicken diets were carried out as described by the procedures of AOAC (2000). The nitrogen free extract was determined by calculation.

Statistical Analysis
Data collected on feed intake, bodyweight, bodyweight gain, feed conversion ratio of the grower pullet diets were subjected to analysis of variance (ANOVA) procedure for 3×3 factorial arrangement as described by Steel and Torrie (1980) using General Linear Model. Where significant difference was found among the treatment means, Duncan Multiple Range Test (DMRT) was used to separate the means (Duncan, 1955).

RESULTS AND DISCUSSION

Feed Intake
Birds on three energy diets (2500, 2700 and 2900kcalME/kg diet) recorded increased feed intake (413.27- 490.68 g, 395.29-450.10 g and 379.30-421.71 g) respectively (Table 2) with increase in crude protein levels at 14, 15 and 16% CP. This result shows that feed intake increases with decrease in energy-protein ratio (EP-ratio) or vice–versa which is in agreement with the results of Nahashon *et al.* (2007) who reported that birds fed on 2900 kcal of ME/kg diet consumed significantly higher feeds than those fed on 3000 and 3100 kcal of ME/kg diet, it was also evident in this study (Table 3). This is also in agreement with the report of Golian and Maurice (1992) who reported that, birds on lower caloric diets tend to consume more feed to meet their energy needs as opposed to those fed diets containing higher caloric. Similarly, birds on protein diets; 14% CP, 15% CP and 16% CP recorded decreased in feed intake with increase in energy level (413.27-379.30g), (462.33-399.41g), (490.68-421.71g) respectively (Table 2). This result also shows that feed intake decreased with increase in energy-protein ratio (EP-ratio). Leeson *et al.* (1993) also reported that low-CP diets significantly depressed appetite in poultry which agrees with the present result (Table 4). Likewise, Farrel *et al.*, 1973; Okoye, 1998) reported a reduction in feed intake with reduced CP-ratio. Yusuf *et al.* (2006) also reported that feed intake was not significantly affected by EP: ratio for both broiler starters and finishers diets.

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Table 2: Interaction Effect of Dietary Energy and Protein on the Performance of Grower Pullet Chickens

	Metebolisable Energy (kcal/kg Diet)									
Protein (%)	2500	2500	2500	2700	2700	2700	2900	2900	2900	
Parameters	14 (LELP) Diet 1	15 (LEMP) Diet 2	16 (LEHP) Diet 3	14 (MELP) Diet 4	15 (MEMP) Diet 5	16 (MEHP) Diet 6	14 (HELP) Diet 7	15 (HEMP) Diet 8	16 (HEHP) Diet 9	SEM
Feed intake (g/wk/bird)	413.27^{de}	462.33^{ab}	490.68^{a}	395.29^{de}	404.55^{de}	450.10^{bc}	376.30^{e}	399.41^{de}	421.71^{cd}	11.47***
Body weight (g/bird)	1248.33^{c}	1367.50^{b}	1535.00^{a}	1145.00^{d}	1236.67^{cd}	1321.67^{bc}	1218.33^{cd}	1300.00^{bc}	1560.00^{a}	31.90***
Body weight gain (g/bird)	861.33^{bc}	868.33^{b}	904.17^{ab}	751.67^{d}	835.83^{bc}	888.33^{b}	748.00^{d}	795.00^{cd}	959.17^{a}	21.77***
Feed conversion ratio	5.28^{bc}	5.87^{ab}	5.96^{a}	5.78^{ab}	5.34^{abc}	5.57^{ab}	5.53^{ab}	5.52^{ab}	4.85^{c}	0.19*
Water Intake (ml/bird/wk)	1031.96^{abc}	1112.32^{ab}	1147.20^{a}	898.16^{c}	955.53^{bc}	978.69^{bc}	932.14^{c}	1020.30^{abc}	1111.45^{ab}	49.16*
Energy-Protein Ratio	178.57	166.67	156.25	192.86	180.00	168.75	207.14	193.33	181.25	

$^{a-e}$ Means in the same row with different superscripts are significantly different (* = P<0.05, *** = P<0.001)
SEM: Standard Error of Mean
LELP--- to HEHP as explained in Table 1

Table 3: Main Effect of Dietary Energy on the Performance of Grower Pullet Chickens

	Energy Levels (kcal ME/kg Diet)			
Parameters	2500	2700	2900	SEM
Feed Intake (g/bird/wk)	455.43[a]	416.65[b]	399.14[b]	11.47**
Body Weight (g)	1383.61[a]	1234.44[b]	1359.44[a]	31.90**
Body Weight Gain (g)	877.94[a]	825.28[b]	834.06[b]	21.77*
Feed Conversion Ratio	5.70[a]	5.56[ab]	5.30b	0.19*
Water Intake (ml/birdiwk)	1097.16[a]	944.13[b]	1021.30[ab]	49.16**

[a,b]Means in the same row with different superscripts are significantly different (P<0.05)
SEM: Standard Error of Mean
NS: Not Significant
wk: Week

Table 4: Main Effect of Dietary Protein on the Performance of Grower Pullet Chickens

	Protein Levels			
Parameters	14% CP	15% CP	16% CP	SEM
Feed Intake (g/bird/wk)	394.95[c]	422.10[b]	454.17[a]	11.47**
Body Weight (g)	1203.89[c]	1301.39[b]	1472.22[a]	31.90**
Body Weight Gain (g)	787.00[c]	833.06[b]	917.22[a]	21.77**
Feed Conversion Ratio	5.53[a]	5.58[a]	5.53[a]	0.19[NS]
Water Intake (ml/bird/wk)	954.09[b]	1029.38[ab]	1079[a]	49.16*

[a-c]Means in the same row with different superscripts are significantly different (P<0.05)
SEM: Standard Error of Mean
NS: Not Significant
wk: Week

Body Weight and Body Weight Gain

Grower pullets fed HEHP and LEHP diets (Table 2) recorded significantly higher body weights of (1560.00 g and 1535.00 g respectively) as compared with those on MELP and HELP diets that recorded the lowest values of 1145.00 g and 1218.33 g respectively. Nahashon *et al.* (2007) reported better body weight on diets containing 2900 ME (kcal/kg) than those on 2800 ME (kcal/kg) Similarly, increased body weight was obtained on diets containing 2900 ME (kcal/kg) diet at high protein level (16% CP) in the present study. This shows that more protein is required for maximum growth of the grower pullets.

Feeding of grower pullet on HEHP and LEHP diets (Table 2) resulted in significantly higher body weights gain of 959.17g and 904.17g respectively as compared with those on HELP, MELP and HEMP of the order of 748.00 g, 751.67 g and 795.00 g respectively, which were the lowest values body weight gain. The result of this study was not in agreement with that of Shehbaz and Sohai (2008) who reported a non-significant weight gain among groups of female and male chicks in his work with Desi Native Chickens. Similarly, Waldroup *et al.* (1976) reported a non-significant body weight gain in broiler finishers, which indicates that energy and protein interaction had no effect on the body weight gain of grower pullets.

Feed Conversion Ratio

This result shows that increasing the CP level of feeds from 14 – 16% significantly increased the feed conversion ratio of grower chickens (Table 2). Birds on diets LEHP and LEMP recorded significantly poorer values of feed conversion ratios of 5.96 and 5.87 respectively, while those on HEHP, LELP and MEMP recorded better feed conversion ratios of 4.85, 5.28 and 5.34 respectively. Fwu and Ali (1995), Murakami *et al.* (1997), (Rosa *et al.* (1997), Yung *et al.* (2001), Wu *et al.* (2005) reported a non-significant difference (P>0.05) in FCR with increasing protein and energy ratio in commercial breeder pullet diets during growing phase.

Water Intake

Water intakes of grower chickens were significantly (P<0.05) influenced by dietary energy and protein (Tables 2-4). At 14, 15 and 16% CP levels, it was observed that birds placed on low energy diets recorded the highest water intake (1031.96, 1112.32 and 1147.20 ml respectively) while those placed on medium energy diets recorded the lowest water intake (898.16, 955.53 and 978.69 ml respectively). This result also showed that at constant energy level (iso-energy diets), water intake of grower chickens increased with increase in crude protein (Table 4). This is in agreement with Mavromichalis (2010) who reported that for every 1% increase in crude protein in feed (that is, above minimal requirements) birds increased water intake by 3%. Agri-Facts (2009) reported 0.040gallons per day (estimated at 1120ml/week) as water intake of Roasters/pullets which in present study agrees with the water intake of grower chickens placed on low energy diet (ranged 1031.96 – 1147.20ml per week) at 14, 15 and 16% CP.

Cost Analysis

The results indicated that at constant protein (14% CP), grower pullets (Table 5) showed increased feed cost (₦/kg) from ₦165.95 (diet1) to ₦327.56 (diet9) with increase in energy-protein ratio and this is also similar at 15 and 16% CP. Cost of total feed intake also increased with increase in energy-protein ratio from ₦754.40 (diet1) to ₦1519.50 (diet 9). Feed cost/kg gain (₦/kg gain) showed that diet1 had the lowest cost (₦649.01) followed by diet 2 (₦771.20) and diet 3 (₦787.01) compared to diets 9 (₦1457.46) which recorded the highest feed cost /kg gain. This finding agrees with Yusuf *et al.* (2006) who reported increased feed cost (₦/kg), cost of TFI (₦) and feed cost/kg gain in a related work with broiler chickens placed on high energy-protein ratio diets.

CONCLUSION

Feeding of experimental grower diets resulted in significant differences in all the parameters measured. MELP and HELP showed a low feed intake, body weight and weight gain compared to other diets. Likewise, LELP and HEHP resulted in low feed conversion ratio compared to MELP while feed cost (₦/kg and ₦/kg gain) was low in LELP, LEMP and MELP. Similarly, feed cost (₦/kg and ₦/kg gain) was highest in HELP and HEMP. It is therefore recommended that, grower pullet chickens be raised at 2700 ME (kcal/kg) diet and 14% crude protein level, to maintained optimum body weight before maturity.

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Table 5: Effect of Dietary Energy and Protein on Cost Analysis of Grower Pullet Chickens

	Metabolisable Energy (kcal/kg Diet)									
	2500	2500	2500	2700	2700	2700	2900	2900	2900	
Protein (%)	14	15	16	14	15	16	14	15	16	
	(LELP)	(LEMP)	(LEHP)	(MELP)	(MEMP)	(MEHP)	(HELP)	HEMP)	(HEHP)	
Parameters	Diet 1	Diet 1	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8	Diet 9	SEM
Total feed intake (g)	4545.92^{de}	5058.67^{ab}	5379.17^{a}	4340.85^{de}	4450.08^{de}	4951.08^{bc}	4139.31^{e}	4393.49^{de}	4638.83^{cd}	127.17***
Total weight gain (g)	861.33^{bc}	868.33^{b}	904.17^{ab}	751.67^{d}	835.83^{bc}	888.33^{b}	748.00^{d}	795.00^{cd}	959.17^{a}	21.77***
Feed cost (₦/kg)	165.95	175.37	183.92	241.20	249.75	258.30	314.06	317.97	327.56	
Feed cost (₦/25kg bag)	4148.75	4384.25	4598.00	6030.00	6243.75	6457.50	7851.50	7949.25	8189.00	
Cost of total feed intake (₦)	754.40	888.14	989.34	1047.01	1093.61	1278.86	1299.99	1397.00	1519.50	
Feed cost/kg gain (₦/kg gain)	649.79	771.20	894.53	787.01	914.07	1136.05	972.39	1110.62	1457.46	
Energy-Protein Ratio	178.57	166.67	156.67	192.86	180.00	168.75	207.14	193.33	181.25	

$^{a-e}$Means in the same row with different superscripts are significantly different (*** = P<0.001)
SEM: Standard Error of Mean
LELP ----to HEHP as explained in Table 1

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