



Effect of Energy-Protein Ratio on the Performance of Laying Chickens in the Northern Guinea Savanna Zone of Nigeria

Yusuf¹, H. B., Yahaya¹, M. S., Yakubu¹, B. and Duwa², H.

¹Department of Animal Science and Range Management, Modibbo Adama University of Technology, PMB 2076 Yola, Nigeria

²Department of Animal Science, University of Maiduguri, PMB 1076 Maiduguri, Nigeria

Corresponding Author: hassanby2003@yahoo.com ; +2348036342466

Abstract

The aim of this study was to investigate the effect of energy-protein ratio on the performance of laying chickens in the northern guinea savanna zone of Nigeria. Two hundred and forty three (243) point of lay pullets (Isa Brown), were randomly allocated to nine treatments, replicated three times in a 3×3 factorial design. The chickens were fed 9 treatment diets containing 3 energy (2500, 2700 and 2900ME (kcal/kg) and 3 crude protein (CP) levels (16, 17 and 18%) respectively. Feed and water were given ad-libitum. Parameters measured include feed intake, body weight, body weight gain, feed conversion ratio, egg production, egg weight, mortality and cost benefit analysis. Laying chickens fed high protein diets (18% CP), recorded the highest feed intake (743.63g/bird/week), feed conversion ratio (13.48), number of eggs produced (5.12/bird/week) and lowest body weight gain (62.48g) and egg weight (53.47g) while those fed low protein diets (16% CP) recorded the highest body weight gain (292.47g), lowest feed intake (597.33g/bird/week), feed conversion ratio (2.43), number of eggs produced (4.19/bird/week) and egg weight (54.11g). Layers fed medium protein diet (17% CP) recorded the highest egg weight (55.22g). The study showed that laying chickens fed low (2500 kcal ME/kg), medium (2700 kcal ME/kg) and high (2900 kcal ME/kg) energy with high protein (18% CP) produced significantly more eggs than those on low (16% CP) or medium (17% CP) proteins. Based on the study, it was concluded that laying chickens perform better on 2500 ME (kcal/kg) diet at 17% CP at lower feed costs. It is therefore recommended that laying chickens should be fed 2500 ME (kcal/kg) diet at 17% CP.

Keywords: Energy:Protein ratio, Laying chickens, Performance

Introduction

Often times poultry feeds are formulated without taking into consideration the energy:protein ratio in relation to egg production, growth and feed conversion efficiency. The chicken attempt to consumed sufficient feed to satisfy its energy requirement (Sizemore and Siegel, 1993). Once the energy requirement is met, chickens will not consume any more feed even if the requirement for other nutrients like proteins, vitamins, or minerals have not been met. Protein helps in body building, growth and development of children in terms of bones, teeth and other reproductive parts (Oni, 2012). Investing in table eggs production is therefore seen as a contribution to the physical and mental

development of Nigerians which on the short and long run will contribute positively to the productivity of Nigerians. Defra (2005) reported that, where feed consumption is decreased due to spells of hot weather, dietary adjustments can help maintain a good supply of nutrients and that protein contributes more metabolic heat than fats and carbohydrates, so a correct energy:protein ratio is important.

Feed quality is measured in terms of adequate amount and correct proportions of the essential nutrients such as protein, minerals and vitamins in relation to the optimum energy content (Salami and Odunsi, 2017) and that the optimum biological performance of farm animals,

especially monogastrics is partly determined by feed quality. The concept of energy:protein ratio (EP ratio) or calorie:protein ratio (CP ratio) is very important in poultry feeding. It ensures adequate protein intake at all possible dietary metabolizable energy levels. It makes possible formulation of high energy diets for maximum growth rate and feed conversion ratio of chickens. The objective of this study was to determine effects of energy:protein ratio on the performance of laying chickens in the northern guinea savanna zone of Nigeria.

Materials and Methods

Study Location

The research was conducted at the University Poultry Research Farm, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria. Yola is Located between latitude 7° and 11°N and longitude 11° and 14°E with altitude of 185.9m above sea level. The area lies within the Northern Guinea Savannah Zone of Nigeria. Maximum temperature of the area reaches 40 °C particularly in April while minimum temperature is 18 °C between December and January. Mean monthly temperature in the state ranges from 26.7 °C in the South to 27.8 °C in the North eastern part of the state (Adebayo, 1999).

Treatments and Experimental Design

The point of lay pullets were allocated to nine treatment groups, replicated three times in a 3 x 3 factorial design. The experimental diets (Table 1), made up the treatments which comprises of three energy levels 2500 (low energy), 2700 (medium energy) and 2900 kcal/kg (high energy) diets; and three protein levels 16 (low protein), 17 (medium protein) and 18% CP (high protein) which were used to obtained the nine treatment diets (Table 1).

Experimental Animals and Management

Two hundred and forty three (243) pullets (Isa Brown) were used for the study.

Records of feed intake and egg production were taken daily while that of body weights were taken at two weeks intervals. Feed conversion ratio and bodyweight gains were also calculated at two weeks intervals. Mortality was recorded as they occur.

A measured quantity of the treatment diets and water were given to each treatment group every day. Left-over feeds and water were weighed every morning to determine the feed and water consumed by each treatment group. The laying chicken's diets were fed for a period of thirty four (34) weeks. Feed and water were given *ad libitum*.

The pullets were reared on deep litter concrete floor for a period of 34 weeks. Each of the 9 treatment diets were fed to 3 pens and each pen contained ten laying pullets. All the birds were fed on their respective treatment diets daily while fresh and clean water were also given *ad libitum*.

The laying chickens were given repeated dose of NDV Kamorov every 3 months as a booster dose throughout the 34 weeks. The birds were also debeaked to avoid cannibalism, egg breakage and drinking.

Measurements

The following parameters were taken: feed intake, body weight, bodyweight gain and feed conversion ratio as described by NIS (1983), Banerjee (1988) and Olomu (2011) while egg production and egg weight were determined as follow:

Egg Production was determined by collecting eggs, three times daily, from each pen between the hours of 7.00 to 9.00 am (morning), 12.00 to 3.00 pm (afternoon) and 4.00 to 6.00 pm (evening). Egg weight was determined by using an electronic digital scale (DHAUS digital scale) having a maximum load of 600g. Eggs collected from each pen (replicate), comprising of ten chickens were weighed

together and mean taken to represent an average weight of that group.

Statistical Analysis

Data collected in respect of feed intake, bodyweight, bodyweight gain, feed conversion ratios and egg production of the layer chickens were subjected to analysis of variance (ANOVA) procedure for 3×3 factorial design as prescribed by Steel and Torrie (1980) using the General Linear Model. Where significant differences were found among the treatment means, Duncan Multiple Range Test (DMRT) was used to separate the means (Duncan, 1955).

Results and Discussion

Feed Intake

The main effects of energy and protein on feed intake of laying chickens (Tables 2 and 3) while Table 4 showed the interaction effect of dietary energy-protein ratio on feed intake of laying chickens. Laying chickens fed low and medium energy (2500 and 2700 kcal ME/kg) resulted in higher feed intake (730.75g and 709.83g) respectively while feeding protein did not result in any significant effect on feed intake among the treatment groups.

The result showed that as dietary energy level increases, birds reduces their feed intake and this is in agreement with Sizemore and Siegel (1993) report that birds tend to eat to satisfy their energy requirements if fed *ad libitum*. This is also in agreement with the results of Oaka and Steamer (1999); Golian and Maurice (1992); Yusuf *et al.* (2006) and Nahashon *et al.* (2007) who reported higher feed intake in birds placed on lower EP-ratio diets.

At medium energy level (2700kcal/kg), feed intake increased with increase in protein level(14-16% CP) but decreases with further increase in protein level (18%CP) which is in agreement with NRC (1984) who reported that absolute requirement for energy in terms of kilocalories per kilogramme of diet cannot

be stated, because poultry adjust their feed intake to obtained their necessary daily energy requirement while ARC (1975), also stated that nutrients should be supplied in proportion to the metabolizable energy (ME) of the diet.

The interaction effects of energy and protein (Table 4) showed that feed intake increased with increase in protein level at constant energy level. Birds on LELP, LEMP and LEHP (low energy diets) recorded the highest feed intake (722.57 g, 726.06 g and 743.63 g) respectively while those on diets with HELP, HEMP and HEHP (high energy diets) recorded the lowest feed intake (597.33 g, 637.16 g and 661.49 g, respectively).

Body Weight and Body Weight Gain

Main effect of energy is not significant ($P>0.05$) for both body weight and body weight gain of laying chickens. However, effect of protein levels resulted in highly significant ($P<0.01$) body weight and body weight gain of laying chickens. High protein (18%) resulted in high body weight (1589.20 g) while low protein (16%) recorded high body weight gain (239.71 g) in laying chickens.

Laying chickens fed high protein (18%) recorded the highest body weights (1595.29 g, 1545.86 g and 1624.29 g, respectively) while those fed low protein (16%) recorded the lowest body weights (1459.46 g, 1437.47 g and 1427.87 g) respectively.

Laying chickens on MELP and MEMP recorded the highest body weight gain (292.47 g and 252.0 g) at 16 and 17% CP compared to LEHP and HEHP which recorded the lowest body weight gain (62.48 g and 65.95 g, respectively) at 18% CP. This result was not in agreement with that of Nahashon *et al.* (2007) who reported a 5% increase in body weight gain of birds on 2900 kcal of ME/kg of diet when compared with those on 2800 kcal of ME/kg of diet. This was also in contrast to

that of Totsuka *et al.* (1993) who reported increased body weight gain with increasing CP levels only when hens were fed the highest CP diet and also that, body weight gain increased significantly with increasing ME levels regardless of the CP levels. In the present study, body weight gain decreased significantly with increasing CP levels (16, 17 and 18%) regardless of the ME levels (2500, 2700 and 2900 kcal ME/kg diet). Similarly, Warldroup *et al.* (1976) and Yusuf et al. (2006) reported increased body weight gain of broilers fed higher EP-ratio diets

The interaction effect of dietary energy and protein on body weight and body weight gain of laying chickens is presented in Table 4. Birds on LEHP, MEHP, and HEHP (high protein diets) recorded the highest body weights (1595.29 g, 1545.86 g and 1624.29 g, respectively) while birds on LELP, MELP and HELP (low protein diets) recorded the lowest body weights (1459.46 g, 1437.47 g and 1427.87 g, respectively).

Iso-protein diets recorded decrease in body weights as EP-ratio increases (LELP, MELP and HELP). In the same trend, iso-energy diets (LE, ME and HE), also recorded increasing body weights with decreasing EP-ratio (Table 4).

Feed Conversion Ratio

Main effect of energy and protein on feed conversion ratio of laying chickens is presented in Tables 2 and 3. Consumption of energy and protein resulted in significant ($P<0.05$) change in feed conversion ratio of laying chickens. Medium energy recorded significantly lower feed conversion ratio (2.85) compared to low and high energy (7.59 and 5.57) respectively. Low and medium protein diets recorded feed conversion ratio of 2.94 and 3.98 compared to 9.09 recorded in high protein (18%) fed laying chickens.

The interaction effect of dietary energy and protein (Table 4) showed significant ($P<0.05$) differences in feed conversion ratio of layers. Feed conversion ratio of laying chickens were significantly ($P<0.05$) influenced by dietary energy-protein (EP) ratio. Diets 4 and 7 (ME-LP and HE-LP) recorded the lowest FCR (2.49 and 2.85 respectively) while diets 3 and 9 (LE-HP and HE-LP) recorded the highest FCR (13.48 and 10.64). This result is in agreement with Nahashon *et al.* (2007) who reported that Pearl Grey guinea fowl hens consuming diets containing 14% CP exhibited FCR that were 25 and 34% lower than those of birds fed diets containing 16 and 18% CP diets at 26 – 50 and 62 – 86 weeks of age respectively. This present result also showed that birds placed on medium-energy diets (2700kcal ME/kg diet) are better feed converters at all protein levels (16, 17 and 18% CP) compared to those placed on low and high energy diets (2500 and 2900 kcal ME/kg) respectively.

Egg Production

The effect of dietary energy and protein on egg production of laying chickens (Table 4). LELP, MELP and HELP recorded the lowest number of eggs laid per bird per week (4.45, 4.27 and 4.19) respectively while MEHP, HEHP and LEHP recorded the highest number of eggs laid per bird per week (5.21, 5.00 and 4.92), respectively.

Interaction effect of energy and protein showed significant ($P<0.001$) differences in egg production of laying chickens. At constant protein level (16 and 17% CP), it was observed that the number of eggs produced per bird per week reduced with increased energy density from 2500 – 2900 kcal ME/kg of the diets. At 18% CP, the number of eggs produced increased with increase in energy density of the diet from 2500 – 2700kcal ME/kg and reduced with further increase to 2900 kcal ME/kg diet. It

was further observed that high protein diet (18% CP) either at low, medium or high energy, produced the highest number of eggs/bird /week while birds placed on low protein diets (16% CP) produced the lowest number of eggs /bird/week. The overall result showed that birds placed on diet 6 (medium energy-high protein diet) produced the highest number of eggs/bird/week (5.21) while those placed on diet 7 (high energy-low protein) produced the lowest number of eggs/bird/week (4.19).

Egg Weight

The effect of dietary energy and protein on egg weight of laying chickens did not show significant ($P>0.05$) differences (Table 4). Data on egg weight of laying chickens showed that EP-ratio had no significant effect on egg weight of laying chickens.

Mortality

The effects of dietary energy-protein ratio on mortality of laying chickens (Table 4) did not show any significant ($P>0.05$) difference.

Cost Benefit Analysis

Cost benefit analysis of laying chickens (Table 5) tend to be influenced by dietary energy-protein (EP) ratios. The cost of producing a kg of the experimental diet was higher in HELP, HEMP and HEHP (high energy diets) which ranged from ₦120.58 to ₦124.52 per kilogramme of the diet and lower in LELP, LEMP and LEHP (low energy diets) which ranged from ₦91.99 to ₦96.63. Yusuf *et al.* (2006) reported increased cost of feed production with increase in EP-ration of the diets. The cost of total feed intake was higher (₦2635.80) in HEHP diets and lowest (₦2127.02) in LELP diet.

Conclusion

The result of this study showed that despite the high temperature condition of Yola, where maximum temperature can reach up to 40°C, most especially in the months of

March and April, laying chickens can be successfully reared to obtain optimum performance when energy-protein ratio is taken into consideration in the formulation of their feeds.

The study showed that laying chickens fed low (2500 kcal ME/kg), medium (2700 kcal ME/kg) and high (2900 kcal ME/kg) energy with high protein (18% CP) produced significantly more eggs than with energy levels with low (16% CP) or medium (17% CP) protein. It can be recommended that:

1. At 2500 ME (kcal/kg) diet, 17% CP is ideal.
2. At 2700 ME (kcal/kg) diet, 18% CP is ideal.
3. At 2900 ME (kcal/kg) diet, 17% CP is ideal.

The general observation is that laying chickens perform better on 2500 ME (kcal/kg) and 17% CP. Therefore, 2500 ME (kcal/kg) diet at 17% CP is recommended for laying chickens in hot climates.

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Table 1: Composition of Experimental Laying Chicken Diets

Ingredients (%)	Metabolizable Energy ME (kcal/kg Diet)									
	2500					2700				
	16 (LELP)	17 (LEMP)	18 (LEHP)	16 (MELP)	17 (MEMP)	18 (MEHP)	16 (HELP)	17 (HEMP)	18 (HEHP)	18%CP
Maize	28.15	28.00	28.00	50.00	50.00	49.00	56.35	56.00	55.50	
Maize Offal	41.00	38.20	35.00	18.45	15.45	13.65	8.00	5.45	3.00	
Groundnut Cake	19.30	22.25	25.45	20.00	23.00	25.80	21.10	24.00	26.95	
Palm Oil	--	--	--	--	--	--	3.00	3.00	3.00	
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
Limestone	6.83	6.83	6.83	6.83	6.83	6.83	6.83	6.83	6.83	
Lysine	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	
Methionine	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	
Salt	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	
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	100

Calculated Analysis

Energy (kcal/kg diet)	2501.19	2503.92	2508.40	2706.25	2710.45	2705.03	2903.30	2904.09	2903.55	
Crude Protein (%)	16.02	17.01	18.10	16.03	17.05	18.01	16.02	17.00	18.01	
Energy-Protein Ratio	156.13	147.20	138.59	168.82	158.97	150.20	181.23	170.83	161.22	

*Premix manufactured by Bio-Mix, supplying the following per 2.5kg: vitamin A,15,500,000.00IU; Vitamin D3,2,750,000.00IU; Vitamin E, 25,000.00mg; Vitamin B1, 2,625.00mg; Vitamin B2, 10,500.00mg; Niacin, 32,500.00mg; Pantothenic Acid, 10,500.00mg; Vitamin B6, 11,250.00mg; Vitamin B12, 85.00 mg; Folic Acid, 1,025.00mg; Biotin, 525.00mg; BHT/Endox, 250,000.00mg; Choline Chloride, 375,000.00mg; Cobalt, 200.00mg; Copper, 15,000.00mg; Iodine, 1,500.00mg; Iron, 125,000.00mg; Manganese, 150,000.00mg; Selenium, 250.00mg; Zinc, 125,000.00mg; Antioxidant, 2,500.00mg.

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, HEHP = High Energy-Medium Protein, HEHP = High Energy-High Protein



Table 2: Effect of Dietary Energy on the Performance of Laying Chickens

Parameters	Metabolizable Energy (kcal/kg Diet)			SEM
	2500	2700	2900	
Feed Intake (g/bird/wk)	730.75 ^a	709.83 ^a	631.99 ^b	20.05 ^{**}
Body Weight (g)	1521.79	1490.66	1517.72	24.13 ^{NS}
Body Weight Gain (g)	2591.41	2496.49	2560.43	21.15 ^{NS}
Feed Conversion Ratio	7.59 ^a	2.85 ^b	5.57 ^a	1.36 ^{**}
Egg Production (No/bird/wk)	4.726	4.731	4.636	0.11 ^{NS}
Egg Weight (g/bird)	54.22	54.06	54.68	0.66 ^{NS}

Means in the same row with different superscripts are significantly different (P<0.05)

SEM: Standard Error of Means

NS: Not Significant

Table 3: Effect of Dietary Protein on the Performance of Laying Chickens

Parameters	Protein Levels			SEM
	16% CP	17% CP	18% CP	
Feed Intake (g/bird/wk)	678.01	693.69	700.88	20.05 ^{NS}
Body Weight (g)	144.6 ^c	1499.4 ^b	1589.2 ^a	24.13 ^{**}
Body Weight Gain (g)	237.71 ^a	197.97 ^b	117.53 ^c	21.05 ^{**}
Feed Conversion Ratio	2.94 ^b	3.98 ^b	9.09 ^a	1.36 ^{**}
Egg Production (No/bird/wk)	4.30 ^c	4.75 ^b	5.04 ^a	0.11 ^{**}
Egg Weight (g/bird)	54.37	54.82	53.77	0.66 ^{NS}

Means in the same row with different superscripts are significantly different (P<0.05)

SEM: Standard Error of Means

NS: Not Significant (P>0.05)

Table 4: Interaction Effect of Dietary Energy and Protein on the Performance of Laying Chickens

		Metabolizable Energy (kcal/kg Diet)											
Protein (%)		2500				2700				2900			
Parameters		16	17	18	16	17	18	16	17	18	16	17	18
		(LELP)	(LEMP)	(LEHP)	(MELP)	(MEMP)	(MEHP)	(HELP)	(HEMP)	(HEHP)	(HEHP)	(HEHP)	(HEHP)
Feed Intake		722.57 ^{ab}	726.06 ^{ab}	743.63 ^a	714.12 ^{ab}	717.84 ^{ab}	697.53 ^{abc}	597.33 ^d	637.16 ^{cd}	661.49 ^{bc}	661.49 ^{bc}	661.49 ^{bc}	661.49 ^{bc}
(g/wk/bird)													
Body Weight		1459.46 ^d	1508.43 ^{cd}	1597.48 ^{ab}	1437.47 ^d	1488.67 ^{cd}	1545.83 ^{bc}	1427.87 ^d	1500.99 ^{cd}	1624.29 ^a	1624.29 ^a	1624.29 ^a	1624.29 ^a
(g/bird)													
Body Weight		211.13 ^b	140.93 ^c	62.48 ^d	292.47 ^a	252.00 ^{ab}	224.17 ^b	209.54 ^b	200.99 ^{bc}	65.95 ^d	65.95 ^d	65.95 ^d	65.95 ^d
Gain (g/bird)													
Feed		3.47 ^b	5.81 ^b	13.48 ^a	2.49 ^b	2.90 ^b	3.16 ^b	2.85 ^b	3.23 ^b	10.64 ^a	10.64 ^a	10.64 ^a	10.64 ^a
Conversion													
Ratio													
Water Intake		2599.95	2578.16	2595.58	2440.66	2490.57	2558.23	2600.79	2613.35	2648.16	2648.16	2648.16	2648.16
(ml/wk/bird)													
Egg Production		4.45 ^{cd}	4.81 ^b	4.92 ^{ab}	4.27 ^d	4.71 ^{bc}	5.21 ^a	4.19 ^d	4.72 ^{bc}	5.00 ^{ab}	5.00 ^{ab}	5.00 ^{ab}	5.00 ^{ab}
(numb/wk/bird)													
Egg Weight		54.11	55.08	53.47	54.39	54.15	53.63	54.61	55.22	54.20	54.20	54.20	54.20
(g/bird)													
Mortality		4	3	3	3	1	0	1	5	6	6	6	6
(numb/treat)													

Means in the same row with different superscripts are significantly different (** = P<0.01, *** = P<0.001)

SEM: Standard Error of Mean

NS: Not Significant (P>0.05)s

LELP ----- to HEHP as in Table 1

Table 5: Effects of dietary energy and protein on cost benefit analysis of laying chicken

Protein (%)	Energy (kcal ME/kg Diet)											
	2500			2700			2900			SEM		
	16 (LELP)	17 (LEMP)	18 (LEHP)	16 (MELP)	17 (MEMP)	18 (MEHP)	16 (HELP)	17 HEMP)	18 (HEHP)	18%CP (HEHP)	SEM	
Parameters												
Total Feed Intake (g)	23122.24	23233.92	23796.96	22851.84	22970.88	22320.96	19114.56	20389.12	21167.68	641.58**		
Feed Cost (₦/kg)	91.99	94.16	96.63	107.17	109.48	110.97	120.58	122.58	124.52	-----		
Feed Cost (₦/25 bag)	2299.75	2354.00	2415.75	2679.25	2737.00	2774.25	3014.50	3064.50	3113.00	-----		
Cost of Total Feed Intake (₦)	2127.02	2187.71	2299.50	2449.03	2514.85	2476.96	2304.83	2490.30	2635.80	48.45***		
Total Weight Gain (g)	316.34	213.83	106.67	382.67	351.00	318.33	276.00	305.33	228.34	21.15***		

Means in the same row with different superscripts are significantly different (** = P<0.01, *** = P<0.001)

SEM: Standard Error of Mean

NS: Non Significant

LELP ---- to HEHP as in Table 1