8-1-2007

Effect of Varying Concentrations of Dietary Crude Protein and Metabolizable Energy on Laying Performance of Pearl Grey Guinea Fowl Hens

Samuel N. Nahashon
Tennessee State University

Nathaniel Adefope
Tennessee State University

Abravi Amenyenu
Tennessee State University

D. Wright
Tennessee State University

Effect of Varying Concentrations of Dietary Crude Protein and Metabolizable Energy on Laying Performance of Pearl Grey Guinea Fowl Hens

S. N. Nahashon,[1] N. A. Adefope, A. Amenyenu, and D. Wright

Institute of Agricultural and Environmental Research, Tennessee State University, Nashville 37209

ABSTRACT This study was conducted to evaluate optimum dietary concentrations of ME and CP for egg production performance of the Pearl Gray guinea fowl laying hens. In a 2 × 3 factorial arrangement, 360 Pearl Gray guinea fowl replacement pullets (22 wk of age) were randomly assigned to experimental diets with 2,800 and 2,900 kcal of ME/kg of diet, each containing 14, 16, and 18% CP, respectively. Each dietary treatment was replicated 4 times, and feed and water were provided ad libitum. Experimental birds were raised in laying cages and received 16 h of light throughout the study period. The birds were observed for feed consumption, hen-day egg production (HDEP), egg weight (EW), egg mass (EM), feed conversion ratio, internal egg quality, shell thickness (ST), and BW at the end of each 28-d lay period at 26 to 50 wk of age and at 62 to 86 wk of age. Mortality was recorded as it occurred. Mean HDEP, EW, EM, and ST were higher ($P < 0.05$) in hens receiving diets with 2,800 kcal of ME/kg of feed than those fed diets containing 2,900 kcal of ME/kg of diet. Hens on 14% CP diets also exhibited higher ($P < 0.05$) HDEP, EM, and ST than those fed diets containing 16 and 18% CP diets. Mean feed conversion ratio of birds on 2,800 kcal of ME/kg of diet and 14% CP diets were significantly lower than those of hens on other dietary treatments. Differences in feed consumption, EW, internal egg quality, BW, and mortality among dietary ME and CP concentrations were not significant ($P > 0.05$). Overall, diets composed of 2,800 kcal of ME/kg of diet and 14% CP were utilized more efficiently by the Pearl Gray guinea fowl laying hens at 26 to 50 and 62 to 86 wk of age.

Key words: Pearl Grey guinea fowl hen, metabolizable energy, crude protein

2007 Poultry Science 86:1793–1799

INTRODUCTION

The effect of diet on the performance of laying chickens has been investigated quite extensively (DeGroote, 1972; Hughes, 1983; Peguri and Coon, 1988; Keshavarz and Nakajima, 1995). However, research conducted to determine the nutritional requirement of guinea fowl laying pullets has been limited. Guinea layers raised in cages lay on average 170 eggs per hen during a 36- to 40-wk lay period, whereas conventionally floor-reared breeders lay between 50 to 100 eggs per season (Hayes, 1987). This translates to high cost of production (Ayorinde and Oluyemi, 1989; Ayorinde, 1991) as a result of poor efficiency in converting feed to eggs. Improving guinea fowl production will minimize the cost of feeding, which accounts for about 60 to 80% of the total cost of poultry production (Pym, 1990). This will in turn profit the guinea fowl industry (Fedkiw et al., 1992).

Performance of layers at sexual maturity and during the laying cycles can be influenced greatly by nutrition. For example, several studies have evaluated the possibility of increasing egg weight (**EW**) through manipulation of nutrients in the diet such as protein (DeGroote, 1972; Keshavarz and Nakajima, 1995), AME_n, and fat content (Sell et al., 1987). An increase in dietary energy significantly improved egg production, EW, and egg mass (**EM**), whereas increasing AME_n in experimental diets of laying hens decreased feed intake and improved feed conversion per dozen and per kilogram of eggs (Grobas et al., 1999). As a result, predictions of ME requirements of laying hens have been recommended (Peguri and Coon, 1988; NRC, 1994).

Keshavarz and Nakajima (1995) conducted experiments to determine the effect of dietary manipulations of energy, protein, and fat during the early stages of egg production of Single Comb White Leghorn pullets. They reported that egg production increased due to increasing the protein or energy levels, although feed consumption (**FC**) was not influenced by these dietary changes. Hughes (1983) fed individual caged hens methionine-deficient or adequate diets. The study showed that egg production was greater for the hens receiving adequate diets.

Improving growth and efficiency of feed utilization in guinea fowl will also reduce soil and ground water contamination that may result from excessive nitrogen

Received January 9, 2007.
Accepted March 7, 2007.
[1]Corresponding author: snahashon@tnstate.edu

Table 1. Composition of experimental diets using 2 levels of ME (2,800 and 2,900 kcal/kg of diet) and 3 levels of CP (14, 16, 18%)

Item	2,800 kcal/kg of ME			2,900 kcal/kg of ME		
	14%	16%	18%	14%	16%	18%
	%					
Ingredient and analysis						
Corn, yellow #2 (8% CP)	70.00	63.76	57.04	67.58	61.16	54.54
Soybean meal (48% CP)	17.27	22.40	27.80	17.60	22.80	28.20
Alfalfa meal (17% CP)	1.00	1.00	1.00	1.00	1.00	1.00
Poultry blended fat	0.80	1.90	3.20	2.90	4.10	5.30
Dicalcium phosphate (18% P, 22% Ca)	1.80	1.80	1.80	1.80	1.80	1.80
Limestone flour (38.8% Ca)	8.43	8.43	8.43	8.43	8.43	8.43
Salt	0.37	0.37	0.37	0.37	0.37	0.37
Vitamin-mineral premix[1]	0.25	0.25	0.25	0.25	0.25	0.25
DL-Met (98%)[2]	0.08	0.09	0.11	0.07	0.09	0.11
Calculated analysis						
ME, kcal/kg of diet	2,800	2,800	2,800	2,900	2,900	2,900
CP	14	16	18	14	16	18
Ca	3.75	3.75	3.75	3.75	3.75	3.75
Total P	0.72	0.72	0.72	0.72	0.72	0.72
Available P	0.53	0.53	0.53	0.53	0.53	0.53
Met	0.32	0.35	0.39	0.32	0.35	0.39
Met + Cys	0.57	0.62	0.69	0.57	0.62	0.69
Lys	0.70	0.83	0.97	0.70	0.83	0.97
Crude fat	3.58	4.38	5.35	5.37	6.27	7.14
Analyzed level						
CP	13.89	15.91	17.93	13.90	15.88	17.92
Crude fat	3.46	4.28	5.27	5.28	6.15	7.01

[1]Provided per kilogram of diet: retinyl acetate, 3,500 IU; cholecalciferol, 1,000 ICU; DL-α-tocopheryl acetate, 4.5 IU; menadione sodium bisulfite complex, 2.8 mg; vitamin B_{12}, 5.0 mg; riboflavin, 2.5 mg; pantothenic acid, 4.0 mg; niacin, 15.0 mg; choline, 172 mg; folic acid, 230 mg; ethoxyquin, 56.7 mg; manganese, 65 mg; iodine, 1 mg; iron, 54.8 mg; copper, 6 mg; zinc, 55 mg; selenium, 0.3 mg.

[2]Degussa Corporation, Kennesaw, GA.

and phosphorus in poultry manure, an environmental concern (Borgida, 1991; Schutte et al., 1992). Considerable amounts of nitrogen are excreted by commercial laying hens to the environment. Furthermore, protein is one of the most expensive components of poultry rations. Therefore, any approach that could potentially reduce the intake, and as a result, the excretion of the nutrient without affecting the hen's productivity would have a significant impact in reducing the environmental pollution. The objective of this study was to evaluate optimum dietary concentrations of ME and CP for egg production performance of the Pearl Gray guinea fowl laying hens.

MATERIALS AND METHODS

Birds and Management

Five hundred sixty day-old Pearl Gray guinea keets were obtained from a commercial source (Ideal Poultry Breeding Farms, Cameron, TX) and raised under standard brooding and rearing techniques (Nahashon et al., 2006). At 22 wk of age (**WOA**), 360 pullets were weighed individually and randomly assigned to individual laying cages (30.5 × 45.7 × 45.7 cm) in a laying house. In a 2 × 3 factorial arrangement, the pullets were randomly assigned to experimental diets with 2,800 and 2,900 kcal of ME/kg of diet each containing 14, 16, and 18% CP (Table 1). The diets were fed in mash form, and feed and water were provided for ad libitum consumption. Each dietary treatment was replicated 4 times. All birds received a 16-h constant lighting regimen throughout the experimentation periods from 26 to 50 WOA and 62 to 86 WOA.

During the laying period, experimental birds were observed for FC, hen-day egg production (**HDEP**), EW, EM, feed conversion ratio (**FCR**), internal egg quality (**IEQ**), shell thickness (**ST**), and BW at the end of each 28-d lay period at 26 to 50 WOA and at 62 to 86 WOA. Five birds from each replicate were identified, and the same birds were weighed at the end of each 28-d period. Eggs were collected for 5 consecutive days at the end of each 28-d period and were used in determining EW, IEQ, and ST. The eggs were weighed individually and broken on a glass break-out stand with a reflective mirror to detect blood spots on the underside of the egg. Albumen heights were measured using a micrometer (B.C. Ames Co., Waltham, MA), the incidence of blood spots was recorded, and Haugh units calculated using the formula described by Roush (1981). Eggshell thickness was determined using a caliper (B.C. Ames Co.). Two measurements from the midpoint of the opposite ends of the longitudinal sections of the egg, and 1 measurement each from the large and small ends of the eggs was obtained. The average of these 4 measurements was considered eggshell thickness for an individual egg. Mortality was recorded as it occurred, and percentage mortality was determined at the end of each 28-d period.

Statistical Analysis

Percent data (HDEP) were transformed into arc sine coefficients prior to analysis. Data were subjected to ANOVA using the GLM procedures of SAS (SAS Institute, 2002) as a 2 × 3 factorial arrangement of dietary treatments with dietary ME and CP as main effects. All variables were analyzed as repeated measurements with the exception of mortality. Correlation analyses between treatment effects and performance variables were also computed using the GLM procedures. The statistical model used for HDEP, FC, FCR, EW, EM, IEQ, ST, BW gain (**BWG**), and mortality was: $Y_{ijklm} = \mu + M_i + P_j + T_k + (MP)_{ij} + (MT)_{ik} + (PT)_{jk} + (MPT)_{ijk} + R_{ijkl} + \beta_{ijklm}$, where Y_{ijklm} = response variables from each individual replication, μ= the overall mean; M_i = the effect of dietary ME; P_j = the effect of dietary CP; T_k = the effect of time period; $(MP)_{ij}$ = the effect due to interactions between dietary ME and CP; $(MT)_{ik}$ = the effect due to interactions between ME and time periods; $(PT)_{jk}$ = the effect due to interactions between dietary CP and time periods; $(MPT)_{ijk}$ = the interactions between ME, CP, and time periods; R_{ijkl} = the interexperimental unit (replications) error term; and γ_{ijklm} = the intraexperimental unit error term. Two-way interactions between CP and ME, CP and time periods, ME and time periods, and the 3-way interactions among ME, CP, and time periods were not significant ($P > 0.05$); thus, data were pooled across periods and analyzed for main effects. Least significant difference comparisons were made between treatment means for main effects when there was a significant F-value. Differences in mortality among dietary treatments were analyzed using the χ^2 method. Significance implies ($P < 0.05$) unless stated otherwise.

RESULTS AND DISCUSSION

The mean FC, HDEP, EW, EM, FCR, IEQ, BWG, ST, and mortality of Pearl Gray guinea fowl hens fed diets containing varying ME and CP concentrations from 26 to 50 and 62 to 86 WOA are presented in Tables 2 and 4, respectively. Differences in mean FC of the guinea fowl layers fed diets containing 2,800 and 2,900 kcal of ME/kg of diet were not significant ($P > 0.05$) at 26 to 50 WOA and 62 to 86 WOA. Contrary to these findings, Grobas et al. (1999) reported a 4% decrease in feed intake when AME_n in experimental diets of Isabrown laying hens (22 to 65 wk of age) was increased from 2,680 to 2,810 kcal/kg. In this study, the lack of significant difference in FC between birds on 2,800 and those on 2,900 kcal of ME/kg of diet may be due to the narrow range of the 2 energy levels (100 kcal of ME/kg of diet) when compared with the dietary AME_n range of the 2 dietary treatments (130 kcal of ME/kg of diet) in the report of Grobas et al. (1999). In related studies, Nahashon et al. (2006) reported that when Pearl Gray replacement pullets were fed diets containing 2,900 or 3,000 kcal of ME/kg of diet, differences in FC were not significant. However, when the ME was increased to 3,100 kcal of ME/kg of diet, a significant difference in FC was observed between birds on 2,900 and those on 3,100 kcal of ME/kg of diet. According to Golian and Maurice (1992) and Leeson et al. (1993), birds consume feed to primarily meet their energy requirement. Mean differences in FC of birds fed the 14, 16, and 18% CP diets were also not significant at 26 to 50 WOA. However, at 62 to 86 WOA, although differences in FC between birds on 14 and 16% CP diets were not significant, feed consumption was about 3% higher ($P < 0.05$) in birds fed diets that contained 18% CP when compared with those fed 14% CP diets. Sterling et al. (2002) evaluated the performance of broiler chicks fed diets with cottonseed meal as the major protein source. They reported that protein source and dietary level significantly ($P < 0.05$) affected feed intake.

Percent HDEP, EW, EM, and ST were significantly higher ($P < 0.05$) by 7, 5, 12, and 6%, respectively, in birds that received diets containing 2,800 kcal of ME/kg of diet than those fed diets containing 2,900 kcal of ME/kg of diet at 26 to 50 WOA (Table 2). A similar pattern was observed at 62 to 86 WOA where birds on 2,800 kcal of ME/kg of diet exhibited HDEP, EW, and EM that were 23, 10, and 31% higher ($P < 0.05$) than those of birds on 2,900 kcal of ME/kg of diet (Table 4). These observations were contrary to the report of Sell et al. (1987) that increasing dietary energy significantly improved HDEP, EW, and EM. In previous studies using broiler breeders, Brake et al. (1989) reported that addition of 2, 4, or 6% poultry fat to broiler breeder diets with respective increase in ME intake increased HDEP. There is likelihood that the energy level of the diets that were not supplemented with poultry fat (Brake et al., 1989) was suboptimal. In the present study, the 2,800 kcal of ME/kg of diet may have provided energy to protein ratio that provided better utilization of dietary energy and protein by the Pearl Gray laying hens. The energy to protein ratio of the diets composed of 14% CP and 2,800 or 2,900 kcal of ME/kg was 200 and 207, respectively. Leeson et al. (1993) and Golian and Maurice (1992) reported that birds would consume feed to primarily meet their energy requirement. Protein utilization, which is essential in egg production, would therefore be highly dependent on this notion. Birds consuming diets with energy to protein ration of 207 would consume less protein than those fed diets with energy to protein ration of 200. Although not statistically significant, BW gain and FC of birds on 2,900 kcal of ME/kg diet were higher than those of birds on the 2,800 kcal of ME/kg of diet, and these may have contributed to the lower performance of the birds on the 2,900 kcal of ME/kg of diet than those on the 2,800 kcal of ME/kg of diet. Excessive caloric consumption may lead to increased BW gain associated with fatness and as a result reduce egg production of laying birds (Rosenboim et al. 1999). In other reports, Summers and Leeson (1993) and Peebles et al. (2000) reported that EW was not changed by increasing dietary energy of Single Comb White Leghorn pullets. Nevertheless, other researchers have re-

Table 2. Laying performance of Pearl Gray guinea fowl hens fed diets with varying concentrations of ME and CP, 26 to 50 wk of age

Item	Feed consumption, g/hen per day	Hen-day egg production, %	Egg weight, g/egg	Daily egg mass g/hen per day	Feed conversion ratio, g of feed/ g of egg mass	Internal egg quality, HU[2]	BW gain[1] g/hen	Shell thickness ($\times 10^{-2}$), mm	Mortality, %
ME,[2] kcal/kg of diet									
2,800	129.5	59.4[a]	39.4[a]	23.4[a]	5.5[a]	78.9	97.6	1.7[a]	0.9
2,900	128.6	55.6[b]	37.5[b]	20.9[b]	6.2[b]	80.7	102.4	1.6[b]	1.2
PSEM[3]	0.82	1.23	0.26	0.52	0.02	0.55	2.85	0.02	0.08
CP, %									
14	128.6	66.6[a]	38.2	25.4[a]	5.1[a]	76.8	93.9	1.7[a]	1.3
16	129.8	51.0[b]	39.0	20.0[b]	6.3[b]	76.7	101.2	1.7[a]	1.1
18	130.5	54.9[b]	38.1	20.9[b]	6.2[b]	75.9	95.8	1.5[b]	0.8
PSEM	0.88	1.62	0.35	0.43	0.06	0.48	2.74	0.02	0.06
	P-value								
ME	NS	0.01	0.01	0.02	0.03	NS	NS	0.05	NS
CP	NS	0.01	NS	0.05	0.04	NS	NS	0.01	NS
ME × CP	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a,b]Mean feed conversion ratios within columns of ME or CP levels with no common superscript differ ($P < 0.05$).

[1]Average BW gain from 26 to 50 wk of age.

[2]HU = Haugh units.

[3]PSEM = pooled SEM.

ported a significant increase in EW with increase in dietary energy intake of commercial leghorns (Harms et al., 2000; Bohnsack et al., 2002; Sohail et al., 2003) and broiler breeders (Spratt and Leeson, 1987). The higher EM in birds fed the 2,800 than those fed the 2,900 kcal of ME/kg of diet may be due to higher HDEP and EW, which were associated with these diets. Positive and significant ($P < 0.05$) correlations between HDEP and EM and between EW and EM (Tables 3 and 5, respectively) support this premise. Feed conversion ratio was 13 and 36% lower ($P < 0.05$) in laying birds that were fed the 2,800 kcal of ME/kg of diet than those fed diets containing 2,900 kcal of ME/kg of diet at 26 to 50 WOA (Table 2) and 62 to 86 WOA (Table 4), respectively. However, differences in IEQ, BWG, and mortality were not significant among the 2 dietary ME concentrations at 26 to 50 WOA and 62 to 86 WOA. On the other hand, the difference in ST was also not significant among the 2 dietary ME concentrations at 62 to 86 WOA.

Mean FC of the Pearl Gray guinea fowl hens was not different ($P > 0.05$) among dietary CP levels at 26 to 50 WOA. However, at 62 to 86 WOA, birds fed diets containing 18% CP consumed 3% more feed ($P < 0.05$) than those fed 14 and 16% CP diets. It was established that birds fed diets containing 14, 16, and 18% CP diets consumed about 18, 21, and 24 g of CP per day, respectively, during 26 to 50 WOA and 62 to 86 WOA. A recent report (Nahashon et al. 2006) demonstrated that Pearl Gray replacement pullets fed diets containing 24% CP diets consumed more feed than those fed diets containing 22 and 20% CP at 0 to 8 WOA. A similar trend was reported at 9 to 16 WOA, whereby FC of birds consuming diets containing 21% CP was significantly higher ($P < 0.05$) than that of birds fed diets containing 19 and 17% CP diets (Nahashon et al., 2006). Mean HDEP and daily EM were 31 and 27% higher ($P < 0.05$) in birds fed diets containing 14% CP than those fed 16 and 18% CP diets at 26 to 50 WOA. At 62 to 86 WOA, percent HDEP and EM were 21 and 34% higher in birds fed the 14% CP diets when compared with those fed the 16 and 18% CP diets, respectively. Because the 14% CP diets seem adequate for the Pearl Gray guinea fowl layers, the decreased production performance of the birds on 16 and 18% CP diets may be due to increased expenditure of energy in catabolism of excess dietary amino acids. Consumption of CP by birds on 16 and 18% CP diets

Table 3. Correlation coefficients among performance traits of Pearl Gray guinea fowl laying hens fed diets with varying concentrations of ME and CP, 26 to 50 wk of age[1]

Item	FC	FCR	HDEP	EW	EM	IEQ	ST
CP	–0.07	–0.12	–0.09	0.02	–0.15	–0.13	–0.12
ME	–0.28*	0.13	–0.16	–0.21*	–0.19*	0.14	–0.16
FC		0.41**	–0.18	0.11	0.08	0.10	0.07
FCR			–0.78**	0.14	–0.12	–0.06	0.08
HDEP				–0.13	0.57**	0.08	–0.05
EW					0.61**	0.11	–0.09
EM						–0.06	–0.10
IEQ							0.19*

[1]FC = feed consumption; FCR = feed conversion ratio; HDEP = hen-day egg production; EW = egg weight; EM = egg mass; IEQ = internal egg quality; ST = shell thickness.

*$P < 0.05$; **$P < 0.01$.

Table 4. Laying performance of Pearl Gray guinea fowl hens fed diets with varying concentrations of ME and CP, 62 to 86 wk of age

Item	Feed consumption, g/hen per day	Hen-day egg production, %	Egg weight, g/egg	Daily egg mass, g/hen per day	Feed conversion ratio, g of feed/g of egg mass	Internal egg quality, HU[2]	BW gain,[1] g/hen	Shell thickness ($\times 10^{-2}$), mm	Mortality, %
ME, kcal/kg of diet									
2,800	130.1	45.8[a]	38.0[a]	17.4[a]	7.2[a]	70.7	102.3	1.6	1.1
2,900	131.3	37.2[b]	35.7[b]	13.3[b]	9.8[b]	70.3	104.7	1.5	0.8
PSEM[3]	1.04	1.62	0.32	0.61	0.14	0.58	2.68	0.30	0.18
CP, %									
14	128.2[b]	50.6[a]	36.5	18.4[a]	6.9[a]	71.2	105.6	1.5	0.0
16	129.3[ab]	41.7[b]	37.9	13.7[b]	9.5[b]	70.1	98.4	1.5	0.6
18	131.5[a]	38.0[b]	36.1	13.9[b]	9.3[b]	70.2	101.8	1.4	0.9
PSEM	1.01	2.01	0.38	0.73	0.26	0.69	2.75	0.04	0.15
	P-value								
ME	NS	0.01	0.04	0.02	0.02	NS	NS	NS	NS
CP	0.05	0.01	NS	0.01	0.01	NS	NS	NS	NS
ME × CP	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a,b]Mean feed conversion ratios within columns of ME or CP levels with no common superscript differ ($P < 0.05$).

[1]Average body weight gain from 62 to 86 wk of age.

[3]HU = Haugh unit.

[4]PSEM=pooled SEM.

was 17 and 33% higher than that of birds fed diets containing 14% CP diets, respectively. It is likely that energy expenditure that would have otherwise been utilized on production performance in birds fed the 16 and 18% CP diets was utilized for the excess amino acid catabolism (MacLeod, 1997). However, previous studies (Keshavarz and Nakajima, 1995) that were contrary to this report have shown that egg production increased due to increasing dietary protein levels although feed consumption was not influenced by these dietary changes. Earlier, Hughes (1983) fed individual caged hens methionine-deficient or adequate diets and reported that egg production was greater for the hens receiving adequate diets. Birds on 2,900 kcal of ME/kg of diet consumed 2.7% more calories/d and exhibited a higher energy to protein ratio than those fed diets containing 2,800 kcal of ME/kg of diet. Much of the energy consumed might have been deposited as fat as reflected in BW gains that were 5% higher in birds on 2,900 kcal of ME/kg of diet when compared with those on 2,800 kcal of ME/kg of diet. Negative correlations between fatness and egg production performance have been reported (Richards et al., 2003). Therefore, the higher BW gains of birds on the 2,900 kcal of ME/kg of diet might have contributed to lower percent HDEP of these birds when compared with those on 2,800 kcal of ME/kg of diet. This may have obscured the ability of the 2,900 kcal of ME/kg of diet from providing a higher ME for the catabolism of excess amino acids in the 16 and 18% CP diets, a factor that could have led to a higher percent HDEP in birds on the 2,900 kcal of ME/kg of diet when compared with those on 2,800 kcal of ME/kg of diet. Differences in EW among dietary CP concentrations were not significant throughout the experimentation period. This observation was consistent with the report of Keshavarz (1998) that dietary energy or protein levels did not have an effect on early egg size or overall performance of Single Comb White Leghorn pullets up to 66 WOA.

Pearl Gray 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 to 50 and 62 to 86 WOA, respectively. Birds fed diets containing 14% CP had higher HDEP and consumed less feed than birds fed diets containing the 16 and 18% CP diets, resulting in a lower FCR in birds on the 14% CP diets when compared with those

Table 5. Correlation coefficients among performance traits of Pearl Gray guinea fowl laying hens fed diets with varying concentrations of ME and CP, 62 to 86 wk of age[1]

Item	FC	FCR	HDEP	EW	EM	IEQ	ST
CP	0.11	–0.05	0.15	0.16	0.21*	0.19*	–0.07
ME	–0.22	–0.16	–0.19*	–0.24*	–0.22*	–0.14	0.04
FC		0.37**	–0.11	0.09	0.13	0.08	0.06
FCR			–0.65**	–0.08	–0.11	0.03	0.07
HDEP				–0.09	0.52**	0.05	0.03
EW					0.59**	0.13	–0.08
EM						–0.05	–0.06
IEQ							0.17*

[1]FC = feed consumption; FCR = feed conversion ratio; HDEP = hen-day egg production; EW = egg weight; EM = egg mass; IEQ = internal egg quality; ST = shell thickness.

$*P < 0.05$; $**P < 0.01$.

on the 16 and 18% CP diets. The positive and significant ($P < 0.05$) correlations between FC and FCR and the negative and significant correlation between FCR and HDEP suggest that birds that consumed less feed (those fed 14% CP diets) had lower FCR and higher HDEP than birds that consumed more feed (those fed 16 and 18% CP diets). Differences in IEQ, BWG, and mortality among birds fed diets containing 14, 16, and 18% CP diets were not significant at 26 to 50 WOA and 62 to 86 WOA.

Correlation coefficients among egg production variables of Pearl Gray guinea fowl at 26 to 50 and 62 to 86 WOA are presented in Tables 3 and 5, respectively. Correlations between FC and ME were negative and significant ($P < 0.05$) at 26 to 50 WOA but not at 62 to 86 WOA. As expected, at both age periods positive and significant ($P < 0.01$) correlations between FCR and FC, HDEP and EM, and EW and EM were observed at both age periods. The variation in FCR and EM was most dependent on the number of eggs produced, hence the higher correlations among these variables. Although the negative correlations between HDEP and EW were not significant ($P > 0.05$), negative and significant ($P < 0.05$) correlations were observed between ME and both EW and EM. Other reports have shown significant increase in EW with increase in dietary energy intake of commercial Leghorns (Harms et al., 2000; Bohnsack et al., 2002; Sohail et al., 2003) and broiler breeders (Spratt and Leeson, 1987). Previous studies (Emsley et al. 1977) have also shown that strain-cross laying chickens exhibited negative correlations between HDEP and both EW and egg specific gravity. Correlations between HDEP and IEQ and between HDEP and ST were not significant as well.

Based on the described conditions under which this study was conducted, diets composed of 2,800 kcal of ME/kg of diet and 14% CP were utilized more efficiently by the Pearl Gray guinea fowl laying hens both at 26 to 50 WOA and 62 to 86 WOA.

ACKNOWLEDGMENTS

This study was supported by USDA-Cooperative State Research, Education, and Extension Service Evans Allen Funds.

REFERENCES

Ayorinde, K. L. 1991. Body weight increase of indigenous pearl guinea fowl in Nigeria through crossbreeding. Br. Poult. Sci. 32:295–302.

Ayorinde, K. L., and J. A. Oluyemi. 1989. Heritability estimates for body weight in the indigenous Pearl Guinea fowl in Nigeria. Nig. J. Genet. VII:19–26.

Bohnsack, C. R., R. H. Harms, W. D. Merkel, and G. B. Russel. 2002. Performance of commercial layers when fed diets with four contents of corn oil or poultry fat. J. Appl. Poult. Res. 11:68–76.

Borgida, L. P. 1991. Pollution from nitrogen and poultry feed formulation. Page 257 in Proceedings of the 8th European Symposium on Poultry Nutrition, Italy. L. P. Borgida Venezia-Mestre, ed. Cambridge Univ. Press, UK.

Brake, J., J. D. Garlich, and G. R. Baughman. 1989. Effect of lighting program during the growing period and dietary fat during the laying period on broiler breeder performance. Poult. Sci. 68:1185–1192.

DeGroote, G. 1972. A marginal income and cost analysis of the effect of nutrient density on the performance of White Leghorn hens in battery cages. Br. Poult. Sci. 13:503–520.

Emsley, A., G. E., Dickerson, and T. S. Kashyap. 1977. Genetic parameters in progeny-test selection for field performance of strain-cross layers. Poult. Sci. 56:121–146.

Fedkiw, J., J. Blake, J. Donald, and W. Magette. 1992. Impact of animal wastes on water quality: A perspective from USDA. Pages 52–62 in Proc. Natl. Livest. Poult. Aquaculture Waste Manage., Kansas City, MO. J. Blake and J. Donald, ed. Am. Soc. Agric. Eng., St. Joseph, MI.

Golian, A., and D. V. Maurice. 1992. Dietary poultry fat and gastrointestinal transit time of feed and fat utilization in broiler chickens. Poult. Sci. 71:1357–1363.

Grobas, S., J. Mendez, C. De Blas, and G. G. Mateos. 1999. Laying hen productivity as affected by energy, supplemental fat, and linoleic acid concentration of the diet. Poult. Sci. 78:1542–1551.

Harms, R. H., G. B. Russell, and D. R. Sloan. 2000. Performance of four strains of commercial layers with major changes in dietary energy. J. Appl. Poult. Res. 9:535–541.

Hayes, C. 1987. Mature guinea fowl management. Pages 169–184 in Raising Turkeys, Ducks, Geese, Pigeons and Guineas. C. Haynes, ed. Tab Books Inc., Blue Ridge Summit, PA.

Hughes, B. O. 1983. The effect of methionine deficiency and egg production on feather loss in caged layers. Br. Poult. Sci. 24:549–553.

Keshavarz, K. 1998. The effect of light regimen, floor space, and energy and protein levels during the growing period on body weight and early egg size. Poult. Sci. 77:1266–1279.

Keshavarz, K., and S. Nakajima. 1995. The effect of dietary manipulations of energy, protein, and fat during the growing and laying periods on early egg weight and egg components. Poult. Sci. 74:50–61.

Leeson, S., J. D. Summers, and L. Caston. 1993. Growth response of immature brown-egg strain pullet to varying nutrient density and lysine. Poult. Sci. 72:1349–1358.

MacLeod, M. G. 1997. Effect of amino acid balance an energy: Protein ratio on energy and nitrogen metabolism in male broiler chickens. Br. Poult. Sci. 38:405–411.

Nahashon, S. N., N. Adefope, A. Amenyenu, and D. Wright. 2006. Effect of varying metabolizable energy and crude protein concentrations in diets of Pearl Grey guinea fowl pullets: 1. Growth performance. Poult. Sci. 85:1847–1854.

National Research Council. 1994. Nutrient Requirements of Poultry. 9th rev. ed. Natl. Acad. Press, Washington, DC.

Peebles, E. D., C. D. Zumwalt, S. M. Doyle, P. D. Gerard, M. A. Latour, C. R. Boyle, and T. W. Smith. 2000. Effect of dietary fat type and level on broiler breeder performance. Poult. Sci. 79:629–639.

Peguri, A., and C. N. Coon. 1988. Development and evaluation of models for metabolizable energy and true metabolizable energy intake for Dekalb XL-Link White Leghorn hens. Pages 199–211 in 49th Minnesota Nutr. Conf. Degussa Technol. Symp., Bloomington, MN. Univ. Minnesota Press, Minneapolis.

Pym, R. A. E. 1990. Nutritional Genetics. Pages 847–876 in Poultry Breeding and Genetics. R. D. Crawford, ed. Elsevier Publ. Co., New York, NY.

Richards, M. P., S. M. Poch, C. N. Coon, R. W. Rosebrough, C. M. Ashwell, and J. P. McMurtry. 2003. Feed restriction significantly alters lipogenic gene expression in broiler breeder chickens. J. Nutr. 133:707–715.

Rosenboim, I., E. Kapkowska, B. Robinson, and Z. Uni. 1999. Effects of fenfluramine on body weight, feed intake, and reproductive activities of broiler breeder hens. Poult. Sci. 78:1768–1772.

Roush, W. B. 1981. TI59 calculator program for Haugh Unit calculation. Poult. Sci. 60:1086–1088.
SAS Institute. 2002. SAS/STAT User's Guide. Version 6. 5th ed. SAS Inst. Inc., Cary, NC.
Schutte, J. B., J. de Jong, and J. P. Holsheimer. 1992. Dietary protein in relation to requirement in poultry and pollution. Pages 231–235 in Proc. 19th Worlds Poult. Congr., Amsterdam, the Netherlands. Cambridge Univ. Press, UK.
Sell, J. L., R. Angel, and F. Escribano. 1987. Influence of supplemental fat on weights of eggs and yolks during early egg production. Poult. Sci. 66:1807–1812.
Sohail, S. S., M. M. Bryant, and D. A. Roland, Sr. 2003. Influence of dietary fat on economic returns of commercial Leghorns. J. Appl. Poult. Res. 12:356–361.
Spratt, R. S., and L. Leeson. 1987. Broiler breeder performance in response to diet protein and energy. Poult. Sci. 66:683–693.
Sterling, K. G., E. F. Costa, M. H. Henry, G. M. Pesti, and R. I. Bakalli. 2002. Responses of broiler chickens to cottonseed- and soybean meal-based diets at several protein levels. Poult. Sci. 81:217–226.
Summers, J. D., and S. Leeson. 1993. Influence of diets varying in nutrient density on the development and reproductive performance of White Leghorn pullets. Poult. Sci. 72:1500–1509.