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Growth Performance, Nutrient Digestibility and Biochemical Traits of Guinea Fowls Fed Varied Levels of Dietary Crude Protein

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Abstract

THIS study examines the effect of varied dietary crude protein levels on growth performance, nutrient digestibility and biochemical traits of Guinea fowls in hot humid environment. This investigation used eighty (80) day-old kits. The birds were grouped into four treatments and each treatment had thirty birds. The birds were fed with diets containing 16, 18, 20 and 22 % crude protein (CP) in a completely randomized design. The results on body weight, weight gain, daily weight and feed conversion ratio were better among birds on 22 % crude protein diet followed by 20 and 18 % crude protein diets and poorer among birds on 16 % crude protein diet. Total and daily feed consumption decreased with increasing crude protein levels in the diet. Nutrient digestibility values of CP, dry matter and gross energy increased significantly with increasing dietary CP levels. However, ether extract levels decreased with increasing dietary CP levels. Albumin and serum protein values increased significantly with increasing dietary CP levels. However, cholesterol and globulin levels decreased with increasing dietary CP levels. This study concludes that, increasing CP levels in the diet of Guinea fowls reduces feed consumption, increases feed utilization and nutrient digestibility, increases immune capacity and promote rapid growth.

Keywords: Production, protein requirement, feed utilization, immune responses, biochemical traits

Introduction

Guinea fowl is among the common bird raised by many small-scale poultry farmers in Ghana most especially in the Northern, Savannah, North East, Upper East and West regions. Hence, the bird is very common and popular in the Northern sector as compared to all the other regions. Pearl Guinea fowl is the dominant breed compared to black, lavender, and white Guinea fowls [1-2]. Guinea fowl is capable of adapting to harsh environmental conditions and growing very fast with high production and reproduction performance [3]. Keeping Guinea fowl has proven to be very profitable with low production input since most rural farmers keep the bird under the semi-intensive and extensive system of animal management [4].

The major constraints affecting the growth and reproduction performance of local Guinea fowl production include: seasonal breeding [5], poor nutrition [6], high reproductive wastage photoperiod [2] and relatively small egg size [4]. Feeding Guinea fowl with the right nutrient and high feeding cost has been a major challenge for Guinea fowl farmers in recent times. Son *et al.*, [7] reported that cost of feeding broilers accounted for 65-75 % of the total production cost. The authors further noted that protein sources of feed alone accounted for 15 % of the 65-75 % cost of feeding. Research conducted by Son *et al.*, [7] and Usturoi *et al.*, [8] revealed that manipulating the crude protein (CP) levels in broiler diet is an alternative solution to reduce the cost of broiler production. Brandejs *et al*., [9] and Son et al., [7] stated that higher levels of crude protein in the diet reduces protein retention and the efficiency of amino acid utilization in broilers.

Brandejs *et al*. [9] reported that farmers should pay much attention to ensure that birds fully utilize the nutrient in the diet for sustainable production

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with focus on reducing cost of production. Unfortunately, this innovative feeding strategy has not been studied extensively hence, there is few scientific study to determine the ideal crude protein levels required for growing Guinea fowls to ensure effective feed utilization. There are so many disparities in literature regarding the nutrient requirement for Guinea fowls as compared with the domestic chicken [6, 10]. Researching to determining the optimum protein level for growing Guinea fowls will improve nutrient availability and efficient utilization leading to rapid growth and high reproductive performance.

Material and Methods

Information about the Study Area

This study was set-up at the Poultry Unit of the Animal farm of the Department of Animal Science Education, University of Education, Winneba, Mampong-Ashanti campus, Ghana and lasted for 24 weeks. The average minimum and maximum temperatures recorded during the study period were 20.89 to 30.4 ^{o}C respectively [11]. The town experiences a bimodal rainfall pattern between April-July and August-November and also experiences a dry season which occurs within December-March

Experimental Animals, Design and Treatments

Pearl Guinea fowls totalling 80 were randomly selected and put on four dietary treatments which comprised 16, 18, 20 and 22 % crude protein (CP). Each treatment was replicated 4 times with 5 birds per replicate in a completely randomized design. Feed and clean water were always made available without restrictions. Health management practices were strictly followed at all stages of growth. The various compositions at the starter, grower and breeder phases are presented in Table 1. The nutrient levels met the National Research Council NRC [12] nutrient requirement for growing poultry.

Experimental Diets

Four different diets were formulated and used for feeding the experimental birds (Table 1).

Growth Traits and Method of Measurement

All the one hundred and twenty birds were considered during the growth performance measurement. The procedure for the determination of initial and final body weight, weight gain, daily weight gain, total and daily feed intake and feed conversion ratio were determined as described by Okyere *et al*., [13].

Nutrient Digestibility of Guinea fowls

At twenty-four weeks of age, fecal samples were collected and scales, feathers and fine particles were removed. The fecal samples were placed in an oven to dry at 60 $\circ C$ for three days and finely ground through a 1 mm screen. Crude protein, dry matter, ether extract and gross energy were determined according to the procedures described by Association of Official Analytical Chemists (AOAC) [14].

Some Biochemical Traits and Methods of Measurement

At the final stage of the experiment, nine birds from each of the treatment groups were randomly selected for blood collection and analysis. Blood from each of the experimental birds was collected in the morning between 7 am - 8 am. from the brachial wing vein using a sterilized disposable syringe and needles [14]. A cotton ball soaked in methylated spirit was used to clean the piercing site to disinfect and dilate the vein to prevent subsequent infections from the wound created by the needle. A five ml volume of blood was drawn from each of the birds for biochemical analysis. The clotted blood samples at room temperature were spun in the centrifuge to isolate the serum from the blood cells for analysis using the method for determining total blood protein described by Keller [15], and the results of the levels were recorded. Bromocresol Green (BCG) and CHOP-PAP methods were used to determine blood albumin and cholesterol levels respectively [14, 15]. The difference between the blood albumin and total blood protein was estimated as the globulin content [15]. Furthermore, Ca^{2+}, K^{+}, Cl^{-} and Na^{+} levels in the blood were determined following the procedures described by Keller [15].

Statistical Analysis

GenStat version 11.1 was used to analyze the data collected during the conduct of this study. The average treatment means were separated using the LSD programmed in the GenStat at a 5% significant probability level. Below is the statistical model used in this study [2];

$Y_{ij} = \mu + \alpha_i + e_{ij}$

μ = The mean of the entire population

α_i = The main effect of crude protein

e_{ij} = Is the error associated with rep k (Crude protein)

Results

Growth Performance of Guinea Fowls Fed Varied Levels of Dietary Protein

The results on body weight, weight gain, daily weight and feed conversion ratio were better (P=0.001) among birds on 22 % CP diet followed by 20 and 18 % CP diets and poorer among birds on 16 % CP diet (Table 2). Total and daily feed consumption decreased (P=0.001) with increasing CP levels in the diet as shown in Table 2.

Nutrient Digestibility of Guinea Fowls Fed Varied Levels of Dietary Crude Protein

Crude protein, dry matter, ether extract and gross energy were significantly (P=0.001) influenced by the levels of crude protein in the diet (Table 3). Nutrient digestibility values of CP, dry matter and gross energy increased significantly (P=0.001) with increasing dietary CP levels. However, ether extract levels decreased with increasing (P=0.001) dietary CP levels (Table 3).

Biochemical Traits of Guinea fowls fed varied levels of dietary crude protein

Results on the dietary CP effect on biochemical traits are shown in Table 4. Albumin and serum protein values increased significantly (P=0.001) with increasing dietary CP levels. However, cholesterol and globulin levels decreased with increasing (P=0.001) dietary CP levels (Table 3). CA^{2+}, Cl^{-}, K^{+} and Na^{+} were not significantly affected by the varied levels of dietary CP considered in this study.

Discussion

This study finding revealed that, feed efficiency and growth performance improved with increasing dietary CP levels which is in agreement with the findings of Liu *et al*., [16] and Son *et al*., [7]. This could be explained that, reduction in CP levels in the diet leads to excessive catabolism of amino acids which results in the building up of toxic ammonia. Son *et al*., [7] reported that, dietary amino acid imbalance due to a reduction in CP levels reduces feed intake and conversion ability, impaired growth and body weight gain in broilers. Hossain *et al*., [17] also attributed the poor growth performance of birds fed lower levels of dietary CP to poor feed intake, low nutritional requirement, less palatability and nutrient digestibility.

Nutrient digestibility was significantly (P=0.001) affected by reduction in dietary CP. Similar results were reported by Son *et al*., [7] who noticed that, a reduction in CP levels lead to low nutrient utilization as observed in this study. It is popularly known that birds feed continuously to meet their nutrient requirements but low levels of dietary CP affects saliva and stomach volume leading to poor nutrient utilization as reported by Liu *et al*., [16] and Son *et al*., [7]. Again, reduction in dietary CP levels leads to a reduction in the essential amino acids in the diet leading to poor nutrient utilization and growth performance as reported by Barekatain *et al.,* [18].

Blood albumin and serum protein are key indicators of nutritional status, ability of the body to synthesis protein, tissue synthesis and immune strength as reported by Park and Kim [19]. Hence it is no surprising that increasing CP levels in the diet resulted in higher body weight. The increasing levels of albumin with increasing dietary protein indicates that, more amino acids will be available for protein synthesis [20].

Conclusion

This study concludes that increasing CP levels in the diet of Guinea fowls promote rapid growth, reduce feed consumption with better feed utilization and better nutrient digestibility. With increasing dietary CP levels, Guinea fowls responded well by producing higher levels of albumin and serum protein with lower levels of cholesterol and globulin.

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Authors Contributions

Author OK is the main author while, CGK is the corresponding author. Authors OK, CGK, JKK and AA conceived and design the experiment. Authors OK and CGK performed the study. Authors JKK and AA supervised and coordinated the study. Authors OK and CGK performed and managed the statistical analysis of experimental data. Authors CGK and OAK prepared the draft of the manuscript. All authors read the manuscript and approved the final version.

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

This research was developed from a completed PhD research work in Reproductive Physiology (Animal Science) with approval from the Animal Care and Ethics Committee from the Department of Animal Science, University of Education Winneba, Mampong Campus. This research also strictly followed the ethics and animal handling guidelines and procedures outline in the Guide for the care and management and use of Poultry Birds in Research and Teaching by the Federation of Animal Science Societies (American Poultry Science Association, 2020).

TABLE 1. Feed ingredients and quantities in the experimental diets

Feed ingredients	Dietary Crude Protein Levels (%)			
	16	18	20	22
Maize	62.50	59.00	55.40	50.00
Wheat bran	18.50	16.20	14.30	14.50
Soya bean meal	8.50	9.30	12.70	16.50
Tuna fish meal	7.50	12.50	14.60	16.00
Oyster shell	1.50	1.50	1.50	1.50
Dicalcium phosphate	0.50	0.50	0.50	0.50
Vitamin premix	0.50	0.50	0.50	0.50
Common salt	0.50	0.50	0.50	0.50
Total	100	100	100	100
Estimated compositions				
Crude fat	5.36	5.38	5.38	5.37
Crude fibre (%)	3.95	3.94	3.94	3.93

Crude protein (%)	16.00	18.00	20.00	22.00
Ether extract (%)	4.52	4.54	4.53	4.53
Calcium (%)	0.81	0.82	0.81	0.83
Phosphorus (%)	0.93	0.95	0.95	0.94
Moisture (%)	10.07	10.08	10.08	10.08
ME (kcal/kg)	2917.5	2918.5	2919.9	2918.5

ME= Metabolizable Energy

Vitamins: A (8010 I.U); B2 (2.09 mg); B12 (5.10 mg); (D3 (1501 I.U); E (2.62 mg) and K (1.53 mg); Folic acid (0.54 mg); Nicotimic acid (8.01 mg); Calcium Panthotenate (2.01 mg); Choline Cloruro (50 mg); Trace elements: Cu (4.65 mg); Co (0.12 mg); mg (48 mg); Se (0.13 mg); Zinc (40.11 mg); Antioxidant Butylated Hydroxytoluene (10.11 mg); Carrier; Calcium carbonate q.s.p (2.63 kg).

TABLE 2. Influence of varied levels of dietary CP on Growth traits

Growth Traits	**Dietary Crude Protein Levels (%)**					
	16	**18**	**20**	**22**	**S.E.M**	***P***
Initial body weight, g/bird	23.17	23.47	23.66	23.56	0.19	0.133
Final body weight, g/bird	1642.00^{d}	1691.30^{c}	1720.71^{b}	1765.32^{a}	3.74	0.001
Body weight gain, g/bird	1618.82^{d}	1667.91^{c}	1697.03^{b}	1741.82^{a}	3.64	0.001
Daily weight gain, g/bird	9.64^{d}	9.93^{c}	10.10^{b}	10.37^{a}	0.02	0.001
Total feed intake, g/bird	3865.32^{a}	3806.71^{b}	3766.06^{c}	3677.74^{d}	7.79	0.001
Daily feed intake, g/bird	23.01^{a}	22.66^{b}	22.42^{c}	21.89^{d}	0.04	0.001
Feed conversion ratio	2.38^{a}	2.28^{b}	2.22^{c}	2.11^{d}	0.01	0.001

^{a,b,c,d} Mean values with different superscript letters in the same rows are significantly different at (P<0.05). S.E.M = Standard error of main effects

TABLE 3. Nutrient digestibility of Guinea fowls fed varied levels of dietary CP

Nutrient Digestibility	**Dietary Crude Protein Levels (%)**					
	16	**18**	**20**	**22**	**S.E.M**	***P***
Crude Protein, %	63.44^{c}	64.38^{b}	68.36^{a}	68.48^{a}	0.18	0.001
Dry Matter, %	78.59^{c}	74.10^{d}	82.62^{b}	84.41^{a}	0.42	0.001
Ether extract, %	90.27^{a}	90.49^{a}	86.57^{c}	86.58^{c}	0.11	0.001
Gross Energy, %	72.77^{c}	74.22^{b}	74.65^{b}	76.91^{a}	0.33	0.001

^{a,b,c,d} Mean values with different superscript letters in the same rows are significantly different at (P<0.05).

TABLE 4. Biochemical Traits of Guinea fowls fed varied levels of dietary crude protein

Biochemical Traits	**Dietary Crude Protein Levels (%)**					
	16	**18**	**20**	**22**	**S.E.M**	***P***
Albumin, g/dl	22.75^{d}	23.83^{c}	33.17^{b}	34.06^{a}	0.90	0.001
Cholesterol,	7.19^{a}	6.71^{b}	5.48^{c}	4.89^{d}	0.14	0.001
Globulin, g/dl	31.33^{a}	29.50^{b}	23.67^{c}	19.33^{d}	0.96	0.001
Serum protein, g/dl	26.50^{d}	31.33^{b}	30.33^{c}	39.67^{a}	0.74	0.001
CA^{2+}, nmol/L	4.20	4.28	4.37	4.33	0.19	0.824
Cl^{-}, nmol/L	112.33	112.50	113.33	112.33	1.54	0.898
K^{+}, nmol/L	4.61	4.09	4.64	4.61	0.27	0.194
Na^{+}, nmol/L	160.31	164.04	163.82	162.61	3.61	0.73

^{a,b,c,d} Mean values with different superscript letters in the same rows are significantly different at (P<0.05).

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