Effects of Graded Dietary Protein on Growth and Laying Performance of Pearl Guinea Fowl (*Numida meleagris*)

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Authors’ contributions

This work was carried out in collaboration among all authors. Authors KO, JKKA, AAA and CGK designed the study, wrote the protocol and wrote the first draft of the manuscript. Author SYA performed the statistical analysis and managed the analyses of the study. Authors KO, CGK, NF and WS managed the literature searches. All authors read and approved the final manuscript.

ABSTRACT

This study was conducted to investigate the effect of dietary crude protein (CP) on growth and laying performance of indigenous Guinea fowls (*Numida meleagris*) in Ghana. A total of Sixty (60) grower pearl Guinea fowl made up of twelve (12) males and forty-eight (48) females were randomly selected and grouped into four made up of (4) females and one (1) male. The groups were each subjected to four experimental diets containing 16%, 18%, 20% and 22% crude protein (CP). A completely randomized design (CRD) was used for the experiment. The data collected were subjected to analysis of variance (ANOVA) using GenStat version 11.1 (2008). Least significant difference (LSD) at 5% was used to separate the means. The result showed that birds fed with diets...
containing 22% crude protein (CP) had the heaviest (P = .05) body weight and body weight gain and reached age at first egg earlier followed by birds fed with diets containing 18% CP, 20% CP and 16% CP respectively. Feed consumption increased with an increase in dietary crude protein. Body weight at first egg was highest (P = .05) among birds fed with diets containing 22% crude protein (CP) and lowest in 16% crude protein (CP). Birds fed with diets containing 20% and 22% crude protein (CP) had the highest (P = .05) hen-day and hen-house egg production, while 16% crude protein (CP) diet recorded the lowest. It was concluded that body weight, body weight gain and total feed intake of indigenous Guinea fowls increased with increasing dietary crude protein. It is recommended to farmers that, diets containing 22% crude protein (CP) is ideal for optimum productivity of indigenous Guinea fowls.

Keywords: Guinea fowl; crude protein; feed intake; body weight; egg laying.

1. INTRODUCTION

Guinea fowls belong to family of insect and seed-eating, ground-nesting birds resembling partridges, but with featherless heads and spangled grey plumage [1]. The Guinea fowl is one of the lesser known poultry species and is a common name for six species of bird native to Africa. One species also occurs on Madagascar and other Indian Ocean islands. Guinea fowl meat has taste similar to other game birds and has many nutritional qualities that make the meat a worthwhile addition to diet [1]. In many parts of the world, Guinea fowls (Numida meleagris) are raised mainly for their gamey flesh and eggs.

In Ghana, Guinea fowls are commonly reared in the Guinea Savannah Zones, covering the Upper East, Upper West and Northern Region [2]. They are relatively disease-resistant and require little attention [1], hence, capital investment for engaging in their rearing is low and this makes it possible for anyone to raise Guinea fowls. Therefore, their potential as an asset for poverty reduction is great especially for disadvantaged groups such as women and children [2,3]. However, the Guinea fowl is now a poultry species kept in other agro-ecological zones in the country such as the coastal savanna and the middle belt of Ghana [3]. Guinea fowl is an integral part of the lives of the people of Northern Ghana and is used for varied functions such as payment for courtship and dowry, gifts and sacrifice [4]. The bird is also used by the Gonjas in the Northern region for the celebration of Guinea fowl festival [1]. The increasing demand for Guinea fowl production order to increase household protein supply, combat rural protein-energy-malnutrition and increase income [5] requires improvement in Guinea fowl productivity since the species naturally is not able to reach its full potential [3,4].

The major hindrances to Guinea fowl production in Ghana are inadequate nutrition [5], low growth rate; high mortality of keets, worm infestation, predation and poor egg hatchability [6]. Scavenging is the main feeding system under free-range Guinea fowl production in rural areas where the birds feed mainly on insects, leaves, grass seeds, tubers and sedges [4,5]. Inadequate nutrition has been singled out as one of the key factors affecting Guinea fowl productivity. The problem facing Guinea fowl production in developing countries including Ghana is inadequate knowledge of the nutritional requirement of the domesticated birds. It pays to give supplements to Guinea fowl for growth from keets stage to maturity if they are kept under semi-intensive or intensive system of management [1,4]. Information on Guinea fowl production is rather lacking in Ghana which hampers rapid development of this industry [4].

In the free-range system, farmers allow the birds to scavenge for most of their feed around the village and are provided with small amounts of supplementary feed in the form of sorghum and millet for keets and whole grains for growers and breeders [7]. It has been demonstrated that Guinea fowl performance depends on access to quality nutrition [8]. For fast growth, Guinea fowl needs to be fed with diet containing crude protein percentage of 24% for the first four weeks. Data on the protein and energy requirement of Guinea fowl pullets intended for use as layers are limiting [8]. To effectively utilize existing local poultry resources to improve poultry production, there is the need to understand the level of dietary protein requirement of the birds.

The aim of this experiment was to investigate the effect of different levels of dietary crude protein (CP) on growth and laying performance of the Guinea fowl (Numida meleagris).
2. MATERIALS AND METHODS

2.1 Experimental Location

The study was carried out at the Poultry Unit of the Animal farm of the Department of Animal Science Education, University of Education, Winneba, Mampong-Ashanti campus, Ghana. Mampong-Ashanti lies in the transitional zone between the Guinea savanna zone of the north and the tropical rain forest of the south of Ghana along the Kumasi-Ejura road. Mampong lies on latitude 07° 03' N and longitude 01° 24'W, on an altitude of 289.7 m above sea level. The rainfall pattern is bimodal, with the major rainfall season occurring from April to July with 1000 mm of rainfall while the minor season occurs from August to November with 350 mm of rainfall. The average daily temperature is between 25°C and 30°C and the average relative humidity of the area is 70% [9]. The experiment lasted for 60 days.

2.2 Experimental Birds and Design

A total of 60 Pearl Guinea fowls comprising 12 males and 48 females of 12 weeks of age were selected and randomly from a flock raised from the poultry unit. The birds were divided into four treatment groups and each was replicated three times in a Completely Randomize Design (CRD). Each replicate comprised one male and four females. The four dietary treatments were: Diet 1, 16% (CP); Diet 2, 18% (CP); Diet 3, 20% (CP) and Diet 4, 22% (CP). The experimental diets and clean water were supplied to the birds ad libitum throughout the experimental period. Vaccination and other routine poultry practices were also carried out.

2.3 Housing, Feeding and Medication

A total of twelve (12) experimental cages were used for rearing the birds, each measuring 1.4 m × 1.34 m and housed five (5) birds. The floor was concreted, and wood shavings were used as litter for the birds. Removable wooden feeding troughs measuring 0.8 m × 0.04 m × 0.03 m were used for feeding the growers. A 4.5-liter watering trough was used for supplying water ad libitum for the growers in each cage. The experimental diets were supplied to the birds ad libitum throughout the experimental period. Vaccination and other routine poultry practices were also carried out.

2.4 Parameters Measured

Parameters measured included: Body weight, feed intake, feed conversion ratio and laying performance.

The experimental birds were weighed at the beginning of the experiment and at the end of the experiment to obtain their initial and final body weight respectively. Feed intake was calculated as the difference between the initial feed offered to birds and the feed left over.

Feed conversion ratio (FCR) was computed as the feed intake divided by the total weight gain.

Arithmetically, FCR = \( \frac{\text{Total feed intake (g)}}{\text{Total weight gain (g)}} \)

The age at first egg (sexual maturity) was estimated to be the age of five percent (5 %) hen-day egg production.

Hen day egg production was therefore calculated as the percentage of the number of eggs laid to the number of hen days.

\[ \text{HDEP} = \frac{\text{Number of eggs laid}}{\text{Number of hen days}} \times 100\% \]

Hen-house egg production

\[ (\text{HHEP}) = \frac{\text{Total number of eggs laid}}{\text{Number of pullets housed at the start of the laying period}} \times 100\% \]

2.5 Data Analysis

The data collected were analyzed using the one-way analysis of variance (ANOVA) according to the procedure of Steel and Torrie [10] and the treatment means were separated by the least significant difference (LSD) to determine which of the treatments has significance difference or not at 5 % probability level [11].

3. RESULTS AND DISCUSSION

3.1 Effect of Different Dietary Crude Protein on Growth Performance

The growth performance of Guinea fowls fed on the dietary treatments for the period of study is shown in Table 2. Results from the present study (Table 2) showed that birds fed with diets containing 22% crude protein (CP) had the heaviest (P= .05) body weight and body weight gain followed by birds fed with diets containing 18% CP, 20% CP and 16% CP respectively.
This means that body weight and body weight gain of indigenous Guinea fowls increased with an increase in the dietary crude protein. This suggests that birds fed with diets containing 22% crude protein (CP) adequately utilized the nutrients they consumed.

The improved body weight and body weight gain observed in the study could be attributed to the different dietary crude protein levels. This could be due to the fact that the birds used the available protein in the diets for the formation and development of their body muscles, which increase body weight and body weight gain. This might be due to the differences in percentage crude protein content. This could also have been influenced by some ingredients in the diets to compel the birds to eat more to meet their body protein requirements. This corresponds with the results reported by [12] and [13]. The authors reported that chicks fed on low CP diet (17%) had a significantly (P=.05) reduced feed intake in comparison to the chicks reared on dietary CP ranging from 19 to 25%.

Feed consumption increased with increasing dietary crude protein (Table 2). Birds fed with diets containing 22% crude protein (CP) had the highest (P=.05) feed intake followed by those fed with diets containing 18% CP, 20% CP and 16% CP respectively. This could be explained that during protein metabolism much energy is required to break down simple protein molecules which stimulate the birds to consume more feed. Growth in animals is influence by genotype of birds, nutrition, hormones, tissue specific regulatory factors and other aspects of the bird’s environment. When birds consume below their protein requirement they do not improve protein utilization. The significant difference in total feed intake observed in this study is in line with the findings of [14] who reported that feed intake of indigenous Guinea fowls increased with an increase in the dietary crude protein. The results of the present study on feed intake are in support of the findings of some works that demonstrated that the reduction in the crude protein levels in the diet affect feed intake of broiler chickens [15] and [16]. However, Ali and Ayorinde [8] reported that growers fed on low crude protein diet had significantly lower feed intake than growers fed higher dietary crude protein. Jiang et al. (2005) reported that increasing dietary essential amino-acids above NRC in fact caused a significant linear reduction in feed intake, possibly because chicken growers were able to meet their amino-acids, crude protein and other nutrient requirements with small intake.

### 3.2 Effect of Different Dietary Crude Protein on Laying Performance

#### 3.2.1 Body weight at sexual maturity

Body weight of both males and females at sexual maturity were significantly (P=.05) affected by different dietary protein levels. The mean body weight of males and females were higher than the weight of birds on both 16% and 18% crude protein. The highest (P=.05) body weight were

| Table 1. Percentage composition of the experimental diet |
|--------------------------------------------------------|
| **Feed ingredients** | Diet 1 | Diet 2 | Diet 3 | Diet 4 |
| Maize | 61.0 | 60.0 | 58.0 | 55.5 |
| Russia fish meal | 2.50 | 5.00 | 6.00 | 9.50 |
| Tuna fish meal | 7.00 | 8.00 | 10.0 | 11.0 |
| Soya bean meal | 7.00 | 8.50 | 10.0 | 10.0 |
| Wheat bran | 18.5 | 14.5 | 12.5 | 10.0 |
| Oyster shell | 2.50 | 2.50 | 2.00 | 2.00 |
| Dicalcium phosphate | 0.50 | 0.50 | 0.50 | 0.50 |
| Vitamin Premix | 0.50 | 0.50 | 0.50 | 0.50 |
| Salt | 0.50 | 0.50 | 0.50 | 0.50 |
| Total | 100 | 100 | 100 | 100 |

| Calculated nutrient composition of the experimental diet |
|----------------------------------------------------------|
| Ash content, % | 11.0 | 8.50 | 10.0 | 9.50 |
| Crude protein, % | 16.0 | 18.0 | 20.0 | 22.0 |
| Crude fibre, % | 5.42 | 4.91 | 4.37 | 4.28 |
| Ether extract, % | 4.00 | 5.50 | 4.00 | 5.00 |
| Moisture content, % | 10.5 | 10.5 | 10.0 | 11.0 |
| Metabolizable Energy, kcal/kg | 2750 | 2750 | 2750 | 2750 |
 obtained for males and females fed 22% protein diet whilst the lowest (P= .05) body weight was recorded in 16% crude protein diet. Increasing dietary protein resulted in increasing body weight at sexual maturity. The improved body weight at first egg could be attributed to the higher crude protein content of the diets which were metabolized and used efficiently for growth [14]. The problems of growth in Guinea fowls can be associated with nutrition and selection. One cannot be sure that the birds were fed optimally. Though guinea fowls have similar gastrointestinal tract is may not be correct that it translate into similar nutrient requirements. There are other factors as genetics which contribute to the nutrient requirements. Various researchers have recommended high protein levels of 15-26% for good performance of guinea fowl with reduction as bird’s mature [8].

Body weight at sexual maturity of females of 1,308.50 g was lower than 1,399.50 g reported earlier [18] of local Pearl Guinea fowls. According to [18] oviposition is dictated by many genetic factors, the physiological threshold necessary for commencement mostly depend on age and body weight which can be improved by improved diet in Plymouth Rock pullets. This report contradicts the earlier studies that body weight at sexual maturity did not change significantly as a result of increasing the dietary crude protein level. Studies have noted that the mature body weight of a broiler breeder hen is more influenced by energy than by protein intake [17,19].

3.2.2 Age at first egg laying

Age at first egg was significantly (P=.05) influenced by increasing dietary protein (Table 3). Birds fed 22% crude protein diet rapidly reached age at first egg earlier than those fed 16% crude protein diet. The mean age at first egg of 182.75 days was longer (P=.05) than 18%, 20% and 22% crude protein levels indicating increasing dietary protein reduced the age at first egg. In this study the mean age at first egg was 182.75 days and was better than earlier report of 255.8 [20,21]. The trends of this study are supported by earlier study where sexual maturity has been delayed by 4 and 8 weeks by feeding 8.9% and 5.1% protein levels, respectively [20,22]. Hockings (2007) concluded that the physiological processes occurring during rearing which underlie ovarian function are reflected solely in the body weight and protein nutrition of broiler breeders at first egg and that increased dietary protein increased fat mobilization for the formation of yellow follicles to release yolk.

3.2.3 Egg size at first egg laying

Birds fed with diets containing 20% crude protein (CP) had the highest egg size at first egg laying followed by those fed with diets containing 22% CP, 18% CP and 16% CP respectively. This could be explained that indigenous Guinea fowls required a maximum of 20% CP in forming and development of eggs. This observation agrees with the finding of [13] and [18] who reported that a reduction in the crude protein levels in the diet during laying stage affect egg laying. The result of this study has demonstrated strong association between dietary protein concentration and first egg weight as first egg weight increased with increasing dietary protein concentration and values were similar to earlier study of [20,23]. This finding is supported by the study of earlier researchers who reported the general tendency of increased egg weight with increasing dietary protein concentration at sexual maturity [24,25] and attributed the increase in egg weight to increase in body weight at first egg resulting from fat deposition [20,22,26].

3.2.4 Hen-day and hen-house egg production

Birds fed with diets containing 20% and 22% crude protein (CP) had the highest (p<0.05) hen-day and hen-house egg production whiles hen-day and hen-house egg production was lower among birds fed with diets containing 16% crude protein (CP). This suggests that hen-day and hen-house egg production increased with an increase in dietary crude protein [17].

Table 2. Effect of different dietary protein level on growth performance

| Parameters              | 16% CP | 18% CP | 20% CP | 22% CP | SEM  | P    |
|-------------------------|--------|--------|--------|--------|------|------|
| Day old body weight, g/bird | 25.3   | 26.1   | 24.8   | 25.9   | 0.28 | 0.11 |
| Final body weight, kg/bird   | 1.26a  | 1.29b  | 1.27c  | 1.35a  | 18.2 | 0.01 |
| Body weight gain, kg/bird    | 1.23d  | 1.27d  | 1.25d  | 1.32a  | 11.2 | 0.01 |
| Total feed intake, kg/bird  | 2.73d  | 2.84d  | 2.77d  | 3.02a  | 12.6 | 0.01 |
| Feed conversion ratio      | 2.22   | 2.23   | 2.22   | 2.28   | 0.07 | 0.13 |

*Means bearing different superscripts in the same row are different at p<0.05, SEM= standard error of means; CP= crude protein*
4. CONCLUSION

It is concluded that body weight, body weight gain and total feed intake of indigenous Guinea fowls increased with an increase in the dietary crude protein. Birds fed with diets containing 22% crude protein (CP) had the highest body weight, body weight gain and consumed more feed as compared to other percentages of crude protein levels used. Guinea fowls fed with diets containing 22% crude protein (CP) consequently experience rapid growth reduced age at first egg. It is recommended to farmers that, diets containing 22% crude protein (CP) is ideal for higher productivity of indigenous Guinea fowls.

ACKNOWLEDGEMENTS

The authors are grateful to the Department of Animal Science Education, Faculty of Agriculture Education, University of Education, Winneba, for providing all the facilities for this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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| Parameters                                      | 16% CP  | 18% CP  | 20% CP  | 22% CP  | SEM  | P     |
|------------------------------------------------|---------|---------|---------|---------|------|-------|
| Body weight of males at first egg laying, g/bird| 1200.6b | 1209.9b | 1303.2b | 1307.5a | 7.34 | 0.01  |
| Body weight of females at first egg laying, g/bird| 1232.4b | 1286.0c | 1345.1b | 1370.3a | 10.8 | 0.01  |
| Age at first egg, days                          | 194.0a  | 180.0b  | 187.0c  | 170.0d  | 2.35 | 0.01  |
| Egg size at first egg laying, g                 | 24.9d   | 27.7e   | 30.4a   | 28.1b   | 1.44 | 0.01  |
| Hen-day egg production, %                       | 65.7b   | 65.8b   | 67.4a   | 67.2a   | 0.77 | 0.04  |
| Hen-house egg production, %                     | 63.8c   | 65.0b   | 66.3a   | 66.3a   | 0.57 | 0.02  |

Means bearing different superscripts in the same row are different at p<0.05, SEM= standard error of means; p = probability of main effects; CP= crude protein
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Peer-review history:
The peer review history for this paper can be accessed here: http://www.sdiarticle4.com/review-history/58576