Effects of dietary energy and protein on performance, reproduction traits and nitrogen-excretion of breeder chukar partridges (Alectoris chukar)

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SUMMARY

This study was carried out to compare the effects of 2 dietary metabolizable energy (2600 and 2900 kcal/kg) and of 2 dietary crude protein contents (13% and 17%) on performance in breeder chukar partridges. A total of 144 breeder chukar partridges (48 males, 96 females), 36 to 52 weeks old, were used in the study conducted as a 2x2 factorial with a completely randomized design. Whereas food intake was significantly depressed in birds receiving a high energy diet, the dietary energy and crude protein contents exhibited no significant effect on growth performance (body weight and body weight gains). Food efficiency, egg weight, egg production, egg mass, fertility and hatchability were not significantly affected by the diet characteristics although a high crude protein content tended to enhance egg production and egg mass and that fertility seemed to be improved with a high metabolizable energy or a high protein level whereas hatchability tended to be inversely affected. A high protein or low energy diets tended to improve the food efficiency for performance. Finally, the nitrogen excretion was significantly additively affected by the dietary energy and protein contents, partridges fed with 2900 kcal/kg and 17% CP in the diet exhibiting a higher nitrogen excretion than the other groups. These results suggest that a diet containing 13% CP and 2600 kcal/kg as metabolizable energy may be supplied to partridges without modification of performance and with reduction of nitrogen excretion.

Keywords: Chukar partridge, dietary energy, dietary protein, growth, laying performance, nitrogen excretion.

Introduction

The composition of diet affects the performance in poultry. Dietary metabolizable energy (ME) and protein levels are known to affect the egg production and egg weights [8, 13, 20]. Previous studies were generally focused on the energy and protein requirements of broilers, quails, layer hens and the other game-birds such as pheasants, but studies on breeder chukar partridges are limited.

The National Research Council [28] reported the dietary metabolizable energy and crude protein (CP) requirements for breeder pheasants as 2800 kcal/kg ME and 15% CP, and for Japanese quails as 2900 kcal/kg ME and 20% CP. LERCLERCQ et al. [22] reported 2900 kcal/kg ME and 14.5% CP as dietary energy and CP requirements respectively in diets for breeder pheasants and 2800 kcal/kg ME and 16% CP for breeder partridges. WOODARD et al. [34] determined the requirements of game-birds as 14% CP and 2900 kcal/kg ME. Others [3] recommended 17% CP and 2900 kcal/kg ME for breeder pheasants and partridges. According to CUFADAR and BAHTIYARCA [7], 13% CP in diet was sufficient for performance, reproduction traits and nitrogen excretion of chukar partridges. KONCA and BAHTIYARCA [21] reported that the breeder quails, fed with different dietary CP levels (21.6, 20, 17 and 15.5%) which had the same lysine content, exhibited no significant change in performance, fertility, and hatchability. In the same way, DJOUVINOV and...
MIHAIOV [9] reported that food intake, egg production and egg mass were not significantly different when Japanese quails received 20.4% or 17.4% dietary CP, the diets being identical for lysine and methionine contents and SHRIVASTAV et al. [31] stated that the dietary CP levels (16, 19, 22 and 25%) did not have significant effect on fertility and hatchability in Japanese quails. Fuentes [11] reported that different dietary levels of CP (14%, 16% and 18%) and of methionine (0.25%, 0.29% and 0.35%) have not significantly altered the egg production and the body weight gain in pheasants but food intake and egg weight were higher when birds received 18% dietary CP compared to the other groups (P < 0.05). NAHASHON et al. [29] determined that guinea fowls should be fed with diets containing 2800 kcal/kg ME and 14% CP for better performance and according to Shim and Lee [30], a maximal hatchability was obtained in breeder quails fed with a diet containing 0.34% methionine, 20% CP and 2650 kcal/kg ME.

On the other hand, nitrogen excretion gradually decreased with reducing dietary CP levels. It is well known that poultry are fed with diets having a higher CP content than most other farm animals, and consequently, poultry manure can be a potential source of nitrogen pollution [23, 25]. Using low CP in diets for game-birds could help to prevent this pollution.

The aims of this study were to investigate the effects of 2 dietary energy levels coupled to 2 different dietary CP contents on performance, reproduction traits and nitrogen-excretion of breeder chukar partridges in laying periods.

Materials and Methods

ANIMALS AND PROTOCOL DESIGN

This study was carried out in the Agricultural Faculty Farm of Selçuk University, Turkey. A total of 144 breeder chukar partridges (48 males, 96 females), 36 to 52 weeks old, were used in the study. Two dietary levels of energy (2900 and 2600 kcal/kg ME) and 2 dietary CP levels (17 and 13%) were tested according a 2x2 factorial arrangement completely randomized design. Each diet was distributed to 36 birds with 2 males, 4 females) per cage, each bird approximately having 600 cm² of floor space. Initially, the prairidge were exposed to a 10-hour light period and controlled temperature between 20 and 22°C. After, the lighting period was increased a quarter hour every day which was provided for 16 hours/day at 32 weeks of age. Water and feed were supplied ad libitum throughout the experiment.

PERFORMANCE ANALYSIS

The prairidges were weighed at the beginning and at the end of the 16 weeks long experimental period. Egg production and egg weight were daily recorded during the laying period.

The egg production (%) was calculated using the following formula: Hen day egg production (%) = [total number of eggs per hen / period (112 days)] x 100. Food intake was recorded biweekly. Egg mass was calculated using the formula: Egg mass = [egg production (%) x egg weight (g)] / 100. Food efficiency was calculated by dividing food intake per bird and per day (g) by egg mass (g).

Fertility and hatchability were determined on collected eggs between the 3rd and the 7th weeks of the experiment. After a 24 days long incubation of eggs at 37.7°C and 65% relative humidity, the number of hatched chicks and not hatched eggs were recorded. Not hatched eggs were broken out and examined to determine the number of infertile eggs. Hatchability was calculated as hatchability of fertile eggs.

Food intake was recorded during the digestion trial. For assessing the nitrogen excretion, excreta were collected 3 times a day (for avoiding ammonia losses from the excreta) during the last week of experiment and they were immediately frozen and stored at −20 °C until further analysis. The nitrogen level in the excreta was assessed using the Micro-Kjeldahl method [4].

STATISTICAL ANALYSIS

A general linear model (GLM) was used for the analysis of variance of the data [12]. Significant differences among means were tested by Duncan’s multiple range tests [26]. Differences were considered as significant when P values were less than 0.05.

Results

As shown in Table II, the breeder chukar partridges exhibited weight loss during the whole experimental period whatever the diet regimen. However, although differences were not statistically significant because of the great value dispersion, the weight loss seemed maximal when birds received diets with a dietary energy of 2900 kcal/kg or with 17% CP at a lesser extend. Consequently, the observed diminution of body weight was maximal in birds fed with 2900 kcal/kg ME coupled to 17% CP. The food intake was significantly increased in partridges by a low energy diet (2900 kcal/kg vs. 2600 kcal/kg: P < 0.05) but remained poorly affected by the crude protein levels: the maximal value of this parameter was recorded in bird group fed with 2600 kcal/kg and 13% CP and was minimal in group fed with 2900 kcal/kg and 13% CP (P = 0.066).

On the other hand, the daily egg production and the egg mass tended to increase when the CP proportion was high in the diets (birds fed with 17% CP coupled to 2600 kcal/kg exhibited the highest values of the both 2 parameters) whereas the mean egg weight was similar among the different groups (Table III). Taking into account the food intake, food appeared to be better converted for laying performance in birds fed with 13% CP and optimal values were recorded in partridges fed with 13% CP and 2600 kcal/kg (P > 0.05). In addition, fertility tended to be improved by a dietary crude...
protein proportion of 17% and at a lesser extend by a high dietary energy: the fertility percentage was maximal in birds receiving 17% CP and 2900 kcal/kg and gradually declined in birds receiving 17% CP and 2600 kcal/kg then 13% CP and 2900 kcal/kg and was minimal in those fed with 13% CP and 2600 kcal/kg. By contrast, the hatchability tended to be inversely modified, increased when the dietary energy or the CP level were low (2600 kcal/kg and 13% respectively).

Nevertheless, the differences were not statistically significant because of the great heterogeneity of the individual values.

Finally, the influences of the diet characteristics (dietary metabolizable energy and crude protein content) on nitrogen excretion were presented in table IV. The nitrogen loss was amplified when the dietary energy was high (2900 kcal/kg; $P = 0.064$) or when the CP content was elevated (17%; 2900 ME (kcal/kg) 2600 ME (kcal/kg)

$\begin{array}{cccccc}
\text{Ingredients (％)} & \text{2900 ME (kcal/kg)} & \text{2600 ME (kcal/kg)} \\
\text{Corn} & 49.5 & 62.9 & 44.0 & 40.2 \\
\text{Soybean meal (47.6% CP)$^1$} & 18.6 & 9.7 & 18.0 & 7.0 \\
\text{Sunflower meal (32.0% CP)$^1$} & 10.0 & 6.0 & 7.0 & 6.0 \\
\text{Barley} & 10.0 & 12.0 & 13.0 & 30.0 \\
\text{Wheat bran} & - & - & 9.25 & 9.00 \\
\text{Vegetable oil} & 3.95 & 1.50 & 0.80 & - \\
\text{Limestone} & 5.30 & 5.24 & 5.45 & 5.30 \\
\text{Di-Calcium phosphate} & 1.85 & 1.99 & 1.70 & 1.85 \\
\text{Salt} & 0.35 & 0.35 & 0.35 & 0.35 \\
\text{Vitamin-mineral premix}$^2$ & 0.30 & 0.30 & 0.30 & 0.30 \\
\text{DL-Methionine} & 0.14 & 0.02 & 0.15 & - \\
\text{Calculated nutrients} & \\
\text{ME (kcal/kg)} & 2901 & 2900 & 2604 & 2602 \\
\text{CP (%)} & 17.01 & 13.03 & 17.04 & 13.02 \\
\text{Ca (%)} & 2.50 & 2.49 & 2.52 & 2.50 \\
\text{Available P (%)} & 2.46 & 2.46 & 0.46 & 2.50 \\
\text{Lysine (%)} & 0.822 & 0.557 & 0.820 & 0.543 \\
\text{Methionine (%)} & 0.400 & 0.238 & 0.404 & 0.231 \\
\text{Methionine + cysteine (%)} & 0.716 & 0.495 & 0.679 & 0.424 \\
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$^1$analyzed value; ME: metabolizable energy; CP: crude protein; $^2$Vitamin-mineral premix provided per kg of diet: Vitamin A: 12000 I.U; Vitamin D3: 2400 I.U; Vitamin E: 25.0mg; Vitamin K3: 4.0 mg; Vitamin B1 (thiamine): 3.0 mg; Vitamin B2 (riboflavin): 5.0 mg; Vitamin B6: 8.0 mg; Vitamin B12: 0.015mg; Niacin: 25.0 mg; Calcium-D-Pantothenate: 8.0 mg, D-Biotin: 0.05 mg; Folic acid: 0.5 mg; Choline Chloride: 125.0 mg; Mn: 80.0 mg; Fe: 60.0 mg; Zn: 60.0 mg; Cu: 5.0 mg; I: 1.0 mg; Co: 0.2 mg; Se: 0.15 mg.

TABLE I: Composition of the diets distributed to 36 week-old breeder chukar partridges (n = 144) for 16 weeks.

TABLE II: Effects of the dietary metabolizable energy level (ME: 2600 and 2900 kcal/kg) and crude protein proportions (13% and 17% CP) on growth and food efficiency in breeder chukar partridges (n = 36 in each group). Results are expressed as mean ± standard error.

Different superscripts a,b in the same column indicate significant differences ($P < 0.05$) according to the diet regimen. Different superscripts A,B in the same column indicate statistical tendencies ($P = 0.066$) according to the diet regimen.
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Table III: Effects of the dietary metabolizable energy level (ME: 2600 and 2900 kcal/kg) and crude protein proportions (13% and 17% CP) on laying performance in breeder chukar partridges (n = 36 in each group). Results are expressed as mean ± standard error.

Table IV: Effects of the dietary metabolizable energy level (ME: 2600 and 2900 kcal/kg) and crude protein proportions (13% and 17% CP) on nitrogen excretion in breeder chukar partridges (n = 36 in each group). Results are expressed as mean ± standard error.

Discussion

The present study showed that dietary metabolizable energy and CP levels did not significantly affect body weight and body weight gain even if high energy or CP levels tended to alter growth in chukar partridges. Similar results have been reported in breeder partridges [7], breeder pheasants [11], bob white quails [1] and Japanese quails [6, 21]. Nevertheless, a negative relationship between food intake and dietary energy levels was recorded in this study leading to improvement of the food efficiency applied to growth performance in birds fed with a low-energy diet. The same observation was reported in laying quails by FREITAS et al. [10] whereas NAHASHON et al. [29] did not describe a significant effect of the dietary energy levels on food intake in laying hens. On the other hand, growth performance was not significantly affected by the dietary crude protein content in the present study as it was previously reported by FREITAS et al. [10].

As far as the laying performance of the chukar partridges was concerned, the egg weight was independent of the studied diet characteristics while the egg production and the egg mass seemed to be slightly increased, although not significantly, by a high dietary crude protein content. In the same way, FREITAS et al. [10] observed a significant reduction of egg mass and egg weight in quails fed with diets containing 16% CP compared to those fed with protein-enriched diets (18, 20 and 22% CP) whereas the egg production was unaffected. However, DJOUVINOV and MIHAILOV [9] did not report any effect of different dietary protein levels (17.4 and 20.4%) on egg production and egg mass in laying hens. Other reports also stated that these parameters were not significantly affected by the dietary energy and essential amino acids (lysine, methionine and threonine) levels in breeder partridges [7] and in breeder pheasants [11]. In addition, a high dietary energy level seemed to positively but not significantly affect the egg mass and the food efficiency towards laying performance in partridges in the present study. Similar results have been reported by other researchers. HERMES et al. [16] reported that in Red-Legged partridges (Alectroric greace) fed with diets which energy ranged from 2600 to 3200 kcal/kg, food intake significantly increased as dietary energy increased, whereas other production traits were not significantly affected by the treatments. Whereas diets with 2600 and 2800 kcal/kg metabolizable energy had no significant

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P = 0.062\] and the significantly highest value of this parameter was recorded in birds fed with diets containing 2900 kcal/kg and 17% CP compared to the other groups \((P < 0.05)\).
effect on hatchability, feeding partridges with high energy diets (3000 and 3200 kcal/kg) significantly increased hatchability compared to partridges fed with 2600 kcal/kg energy diet. WALDIE et al. [33] conducted an experiment in squabbling pigeons, around 3 years old, receiving 3 different energy levels (2600, 2900 and 3150 kcal/kg diet) in isonitrogenous diets (15% CP) and observed that food intake decreased as dietary energy levels increased, leading to an identical energy supply for birds and they reported that egg production, body weight and fertility were not influenced by the treatments, whereas hatchability decreased in birds fed with 2650 kcal/kg. Several studies in laying hens have shown that increasing dietary energy significantly decreased food intake [15, 32, 35, 36], significantly increased egg mass [15, 36] and improved food conversion [32, 35, 36]. But, other works reported no significant effect on egg mass [32, 35], egg weight [18, 32] and egg production [15, 32]. GUNAWARDANA et al. [14] reported that dietary energy levels had no significant effect on any parameters (food intake, food conversion, egg production, egg weight, egg mass and final body weight), albeit these parameters numerically increased as dietary energy increased. SINGH et al. [32] reported that changes in food intake were mainly attributable to dietary energy levels while diet density had little influence on food intake. As energy content increased in the diet, food intake normally decreased, resulting in decreased nutrient intake (such as protein and amino acids) and this situation might affect other performance traits. These discrepancies would be resulted from variable requirements in dietary energy and crude proteins according to the bird species.

Although variations were not statistically significant, fertility and hatchability appeared to be inversely modified by the dietary energy and protein contents: whereas fertility seemed to be enhanced by high energy and protein levels, hatchability appeared depressed in parallel. Nevertheless, CUFADAR and BAHTIYARCA [7] stated that dietary amino-acids supplementation did not significantly affect the fertility and hatchability in partridges and KONCA and BAHTIYARCA [21] reported that the effects of protein, methionine and total sulphured amino acids levels in diet were not significant in Japanese quails. Similar results were obtained by SHRVASTAV et al. [31] in quails and ABOUL-ELA et al. [1] in Bobwhite hens.

The nitrogen consumption was dependent from the dietary protein content: when the protein intake decreases, the nitrogen consumption decreases as well. MELUZZI et al. [25] have established a positive correlation between dietary protein levels and nitrogen excretion. In the present study, the nitrogen excretion reached significant high values when partridges were fed with a high energy diet containing 17% CP compared to the other diet regimens (P < 0.05). In the same way, CUFADAR and BAHTIYARCA [7] stated that decreasing dietary protein levels resulted in a significant decrease of the nitrogen excretion in breeder chukar partridges. Similar results were also seen in laying hens [24]. Moreover, BLAIR et al. [5] showed that added lysine, methionine, threonine and tryptophan to 13.5% CP dietary level in 28 week old layer hens reduced the nitrogen excretion by 30-35% compared to the control group receiving 17% CP in diet. JAIS et al. [17] showed that nitrogen excretion was reduced in 26-62 weeks old laying hens fed with low protein diets (11, 13 and 15%) containing recommended amino acids [27] by 20, 33 and 48% respectively compared to birds fed with high protein diets (17% CP).

In conclusion, except food intake and nitrogen excretion, growth performance and reproduction traits of breeder partridges were not significantly affected by dietary energy and CP levels. Food intake significantly declined in birds fed with high energy diets whereas the nitrogen excretion was significantly exacerbated in partridges receiving high energy and protein diets. Consequently, the breeder partridges can be fed with the diet containing 13% CP and 2600 kcal/kg ME without significant reduction of growth and laying performances and with subsequent decline of nitrogen excretion.

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References