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EFFECT OF LOW PROTEIN LEVEL ON PERFORMANCE OF GROWING AND LAYING JAPANESE QUAILS (*COTURNIX COTURNIX JAPONICA*)

D. DJOUVINOV[1] & R. MIHAILOV[2]

[1]Faculty of Veterinary Medicine, [2]Faculty of Agriculture, Trakia University, Stara Zagora, Bulgaria

Summary

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Two trials were carried out. In trial one, group S was fed starter and grower with 23.4% and 18.2% crude protein (CP) content, respectively. For group L diets had lower protein content − 22.1% and 16.7%, respectively. Feeds for both groups were formulated to be isoenergetic and to have the same level of digestible lysine and methionine. The daily feed intake and weight gain were not affected by the treatments.

In trial two, laying quails from group S were fed diet with 20.4% CP and laying quails from group L received diet with 17.4% CP. The feeds did not differ in energy and digestible lysine and methionine+cystine content.

The reduction of protein content of diets with 1.5 points for growing and with 3 points for laying quails (compared to NRC standards) when digestible amino acid content was kept balanced, had no adverse effect on the performance and had beneficial effect on the performance of Japanese quails during heat stress. Implication of diet formulation on digestible amino acids basis in Japanese quails needs further investigation.

Key words: Japanese quails, low protein, level, performance

INTRODUCTION

One of the most expensive and deficient compounds of feeds for farm animals is the protein source. On the other hand, the protein quantity and quality are the main factor limiting the animal performance. For this reason the attempt of nutritionists is to find cost effective and environment friendly solutions for utilization of protein rich feeds.

Traditionally, the levels of crude protein (CP) and of total essential amino acids (AA) are criteria for least-cost feed formulation for monogastrics. In recent years, the model for "ideal protein" (Baker & Han, 1994; Emmert & Baker, 1997; Baker, 2003) is being more widely applied by the poultry nutritionists. The increased scientific knowledge on amino acid digestibility of feeds and requirements of domestic fowl (NRC, 1994; CVB, 1996; Degussa, 1996; Baker, 2003) allowed poultry feeds to be formulated on the basis of digestible amino acids. This approach is more closely related to the real AA requirements of poultry and gives the option for better utilizing of protein by-products different than soya bean meal and fish meal. The issue of poultry feeds formulation on the basis of digestible AA in Japanese quails is not adequately studied.

The present experiments aimed to study the effect of low protein diets, balanced on digestible lysine and methionine, on productive performance of growing and laying Japanese quails.

MATERIALS AND METHODS

Two experiments were carried out. In Experiment 1, two hundred Japanese quails at hatch were randomly assigned in two groups. Group S (n=100) was fed starter (0–3 weeks) and grower (4–6 weeks), balanced according to NRC (1994) standards – with 23.4% and 18.2% crude protein (CP) content, respectively. Starter and grower for group L (n=100) had lower protein content - 22.1% and 16.7%, respectively. The compound feeds of two groups were formulated to be isoenergetic and to have the same level of digestible lysine and methionine. Digestibility coefficients of feedstuffs (Degussa, 1997) were used for calculation of digestible lysine and methionine content. Decreased CP content in diet L was at the expense of reduced levels of soyabean and fish meals but digestible lysine and methionine concentrations were equal to these of diet S due to addition of synthetic L-lysine and DL-methionine.

Both groups were kept in pens with concrete floor covered with pine wood shavings litter to a depth of 5 cm. The stocking rate of each floor pen was 120 quails/m^2 during the first 3 weeks and 70/m^2 birds during the last 3 weeks of the experiment. The birds received continuous artificial lighting daily during the first three weeks and 17 h afterwards. The ambient temperature was maintained at 34–36°C during the 1st week and was decreased by 5°C weekly for the next three weeks. During the weeks 5 and 6 the temperature was maintained at 20–22°C.

Feed and water were supplied for *ad libitum* consumption.

Body weight (BW) of quails was individually registered on 7-day interval until 42 days of age. From 21 days, the sex dimorphism was already manifested and males and females were weighed separately.

At age of 42 days, female quails from Experiment 1 were allocated into two groups for Experiment 2. Group S (n=30) was fed diet balanced according to NRC (1994) standards and consisted of quails grown on S starter and S grower. Group L (n=30) received low protein diet and consisted of quails reared on L starter and L grower. The compound feed of group L had CP content with 3 points lower compared to group S but the same energy, lysine and sulfur AA content.

Quails were kept in cages which provided 200 cm^2 per bird. Feeding was *ad libitum* and quails had free access to fresh drinking water. Seventeen hours of artificial lighting at bird level were provided daily.

Experiment 2 lasted 5 weeks and egg production and egg weight were recorded daily after birds reached 11 weeks of age.

The ingredients and nutritional value of diets for Experiment 1 and Experiment 2 are given in Table 1 and Table 2, respectively.

The proximate analysis of feeds was performed using procedures detailed by the Association of Official Analytical Chemistry (AOAC, 1990).

The data obtained were expressed as means and standard deviations and were subjected to statistical analysis by Student's *t*-test (Snedecor and Cochran, 1967).

Table 1. Composition and nutritional value of diets with standard (S) and low (L) levels of protein for growing Japanese quails

Item	Starter (0–3 weeks)		Grower (4–6 weeks)	
	S	L	S	L
Ingredients, %				
Maize	47	51	49	49
Wheat	12	13	23	26.63
Soya bean meal	29	26	14	12
Sunflower meal	3.54	3.86	8.58	8.58
Fish meal	6	3	2	–
L-lysine	–	0.3	0.27	0.45
DL-methionine	0.06	0.14	0.05	0.09
Sodium chloride	0.25	0.3	0.25	0.3
Limestone	1.4	1.4	1.3	1.3
Dicalcium phosphate	0.5	0.75	1.3	1.4
Vitamin and mineral premix*	0.25	0.25	0.25	0.25
Nutritional value				
Moisture **, %	9.9	9.7	10.1	9.4
Metabolizable energy ***, MJ/kg	11.9	12.0	12.0	12.0
Crude protein **, %	23.4	22.1	18.2	16.7
Ether extracts**, %	4.9	4.0	4.1	3.4
Ca**, %	0.99	1.07	1.13	1.01
P**, %	0.55	0.52	0.61	0.59
P available***, %	0.30	0.30	0.38	0.38
Lysine**, %	1.33	1.34	1.00	0.99
Methionine**, %	0.47	0.46	0.35	0.34
Methionine+cystine**, %	0.87	0.86	0.67	0.64
Digestible lysine***, %	1.21	1.23	0.92	0.90
Digestible methionine***,%	0.41	0.44	0.32	0.31
Digestible methionine+cystine***, %	0.73	0.73	0.58	0.56

*Premix provided per 1 kg of compound feed: vitamin A – 9500 IU, vitamin D_3 – 3050 IU, vitamin E – 30 mg, thiamine – 1 mg, riboflavin – 6.5 mg, pyridoxine – 2 mg, biotin – 0.05 mg, folic acid – 0.375 mg, Ca-panthotenate – 10 mg, Fe –54 mg, Zn – 50 mg, Cu – 5 mg, Mn – 80 mg, I – 1 mg, Se – 0.2 mg; **Proximate analysis; ***Calculated analysis.

RESULTS AND DISCUSSION

Experiment 1

The changes in BW of growing quails during 42-day experimental period did not demonstrate any significant effect of the treatments. The growth of birds from group L was similar to this of group S at any stage. At age of 21 days both sexes already showed dimorphism but there were not differences in BW (Table 3). When 28 days aged, females had 8–9 g higher BW than males and this difference

Table 2. Composition and nutritional value of diets with standard (S) and low (L) levels of protein for laying Japanese quails

Item	Diets	
	S	L
Ingredients, %		
Maize	62.60	68.93
Soya bean meal	24	20
Fish meal	6	3
L-lysine	-	0.35
DL-methionine	0.05	0.15
Sodium chloride	0.2	0.22
Limestone	5.9	5.9
Dicalcium phosphate	1.0	1.2
Vitamin and mineral premix*	0.25	0.25
Nutritional value		
Moisture**, %	11.7	11.7
Metabolizable energy ***, MJ/kg	11.8	11.9
Crude protein **, %	20.4	17.4
Ether extracts**, %	3.2	3.3
Ca**, %	2.50	2.50
P**, %	0.63	0.59
P available***, %	0.36	0.35
Lysine**, %	1.15	1.16
Methionine**, %	0.40	0.43
Methionine+cystine**, %	0.73	0.72
Digestible lysine***, %	1.04	1.07
Digestible methionine***,%	0.36	0.40
Digestible methionine+cystine***, %	0.63	0.64

*Premix provided per 1 kg of compound feed: vitamin A – 9500 IU, vitamin D_3 – 3050 IU, vitamin E – 30 mg, thiamine – 1 mg, riboflavin – 6.5 mg, pyridoxine – 2 mg, biotin – 0.05 mg, folic acid – 0.375 mg, Ca-panthotenate - 10 mg, Fe –54 mg, Zn – 50 mg, Cu – 5 mg, Mn – 80 mg, I – 1 mg, Se – 0.2 mg; **Proximate analysis; ***Calculated analysis.

increased up to 19–24 g at the end of the trial.

The total BW gain for 42 days was within the ranges of 146-147 g for males and of 171–175 g for females and consequently, the average BW daily gain was not affected by the CP levels of the diet. Daily feed intake, found in the present experiment, was close to the data reported by Angulo *et al*. (1993). The lack of significant differences in feed intake and the same BW gain, determined the similar feed conversion ratio in group S and group L.

Similar results were obtained by Marinov (1984) in broiler chickens. In his experiments, three points reduction in protein content of starter and finisher, compared to NRC (1994) standards has not depressed the performance of birds when lysine and methionine contents were balanced using synthetic AA.

Calculated digestible AA content (Degussa, 1997) of tested feeds demonstrated that starter L and grower L from one hand, and starter S and grower S from other hand, had the same digestible lysine, methionine and methionine+cystine levels (Table 1). This might be the possible explanation for the maintained production performance of quails despite the reduced CP content. On the other hand, such a suggestion should be taken with caution and needs verification based on digestibility trials in Japanese quails.

The advantages of diet formulation based on digestible AA versus total AA were demonstrated by Rostagno *et al.* (1995) in broiler chickens.

Experiment 2

Laying performance of quails, in terms of egg production, feed intake and egg weight, was found to be not influenced by the dietary CP level (Table 5) during the first three weeks of the trial.

Similarly, Bougon & Joly (1990) has found that diet with 15.8% CP content and

Table 3. Body weight (mean±SD, g) of growing Japanese quails fed diets with standard (S, n=100) and low (L, n=100) protein levels

Age, days	Diets			
	S		L	
	♂	♀	♂	♀
1	8.3±0.7*		8.7±0.5*	
7	31.3±2.3*		30.1±2.8*	
14	63.1±6.5*		61.3±5.9*	
21	97.0±11.7	95.7±11.6	98.3±10.3	96.5±11.7
28	123.8±10.9	132.3±12.2	127.7±13.1	130.0±11.1
35	144.8±8.5	163.7±17.4	144.5±8.1	167.3±15.0
42	154.8±9.9	183.6±17.5	156.1±7.3	180.8±16.4

*Means for both sexes.

Table 4. Production performance (mean±SD, g) of growing Japanese quails fed diets with standard (S, n=100) and low (L, n=100) protein levels

Item	Diets			
	S		L	
	♂	♀	♂	♀
Live weight gain				
total for 42 days, g	146.50±9.1	175.30±16.6	147.40±8.3	172.10±17.2
average, g/day	3.49±0.22	4.17±0.35	3.51±0.20	4.10±0.28
*Feed intake**				
total for 42 days, g	602.70±6.15		614.01±7.32	
average, g/day	14.35±0.15		14.62±0.17	

*Means for both sexes.

Table 5. Egg production (mean±SD, %) and egg mass (mean±SD, g) of laying Japanese quails fed diets with standard (S, n=30) and low (L, n=30) protein levels at normal (20-23°C) and high (27-31°C) ambient temperature

Item	Diets	
	S	L
Temperature – 20–23 °C		
Feed intake, g/day	24.4±0.45	25.8±0.32
Egg production, %	85.3±6.4	86.7±6.6
Egg mass, g	10.8±0.43	11.0±0.42
Temperature – 27–31 °C		
Feed intake, g/day	20.5±0.52[a]	23.9±0.64[b]
Egg production, %	69.0±11.2	75.9±10.5
Egg mass, g	10.4±0.32[a]	11.0±0.24[b]

[ab]Means with different superscripts within the same row differ at $P<0.05$.

balanced levels of digestible lysine and methionine resulted in the same egg production of laying hens as 17% CP.

Weeks four and five of the experiment coincided with hot summer weather. The room temperature increased above the range of comfort due to the lack of facilities for climate control. For this reason, the data of quail performance for weeks 1–3 and weeks 4–5 were considered separately. During weeks 1–3, the room temperature varied between 20 and 23°C. The last day of week 3 and first two days of week 4 the temperature increased from 23 to 27°C. The rest of the experiment continued under fluctuation of the temperature from 27 to 31°C. Raising in ambient temperature depressed feed intake and egg production of birds (Table 5). Laying rate dropped from 85% to 68% for quails fed diet S and from 87% to 76% for those receiving feed with lower CP level (diet L). In addition, daily variations in laying rate increased in heat stressed birds, which resulted in higher coefficient of variation. Although the difference in laying performance between diet S and diet L was 7 points, it did not reach significance at $P<0.05$ (Table 5).

Negative effect of hot environment on feed consumption and egg production of laying hens has been found by Savory (1986). Waibel & MacLeod (1995) stated that at high ambient temperature in addition to disturbed body heat loss, heat production per metabolic weight was higher that in a cool environment. Heat-stressed birds ingest less feed as a reaction for reducing the thermogenic effect of nutrient utilization (Withers, 1992) and improving of body temperature maintenance.

Other factors contributing to depressed performance of quails could be changes in nutrients digestion. In animals exposed to heat stress, blood flow to respiratory tract and other organs active in heat dissipation increases at the expense of decreased capillary flow to digestive system (Wolfenson, 1986). Reduced proteolytic activity in gastrointestinal tract may depress the efficiency of protein utilization (Bottje & Harrison, 1987). Contrary to these findings, Koelkebeck *et al.* (1998) have not found significant differences in AA digestibility of feeds in laying hens, raised at 21°C compared to birds exposed to temperature of 29–35°C.

Not only the egg production, but egg weight for group S was influenced by the increased ambient temperature (Table 5). Eggs were heavier for quails, fed low protein diet (group L) than birds fed high protein diet (group S).

The data showed that heat stress affected more adversely quails consuming feed with 20.4% CP than layers fed 17.4% CP diet. Most likely, the thermoregulatory function of birds on high CP diet was influenced at greater extent. This could be associated with bigger protein load of quails. It is known that metabolism of feed protein and excretion of nitrogen compounds lead to increased heat production compared to carbohydrates and fats (Musharaf & Latshaw, 1999).

CONCLUSIONS

Diets for growing and laying Japanese quails, calculated on digestible amino acid basis, supported the same production performance regardless of the tested crude protein levels. Implication of digestibility coefficients of amino acids in feedstuffs for Japanese quails needs further investigation.

Reduced crude protein content had beneficial effect on the performance of laying quails at high ambient temperature.

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Correspondence:

Asoc. Prof. D. Djuvinov,
Section of Nutrition, Dietetics and Veterinary Sanitary Expertise of Feeds,
Faculty of Veterinary Medicine,
Trakia University,
Student's Campus,
6000 Stara Zagora, Bulgaria.