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Nutritional requirements of digestible methionine + cystine for Japanese quails in production phase

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ABSTRACT - This experiment was carried with Japanese quails in the egg production phase with the objective of determining the requirements of digestible methionine + cystine (M+C) for higher production and egg quality. A total of 240 Japanese quails were distributed in a randomized complete block design. The basal diet was supplemented with different DL-methionine levels, corresponding to digestible methionine + cystine levels of 0.55, 0.61, 0.67, 0.73 and 0.79%. The characteristics analyzed were feed intake (g/quail/day), egg production (%), egg weight (g), egg mass (g/quail/day), feed conversion (dozen eggs/egg mass and kg feed/dozen eggs), egg shell (% and g), albumen (% and g), yolk (% and g) and specific gravity (g/cm^3). The digestible M+C level for Japanese quails was 0.696% in the diet, corresponding to a daily intake of 186.7 mg/quail.

Key Words: egg production, egg quality, sulfur amino acids

Exigência nutricional de metionina + cistina digestível para codornas japonesas na fase de postura

RESUMO - Um experimento com codornas japonesas na fase de produção de ovos foi desenvolvido com o objetivo de determinar a exigência de metionina + cistina digestível para maior produção e melhor qualidade dos ovos. Foram utilizadas 240 aves distribuídas em delineamento em blocos inteiramente casualizados, alimentadas com uma ração basal suplementada com DL metionina, de forma a se obterem 0,55; 0,61; 0,67; 0,73 e 0,79% de metionina + cistina digestível. As características de desempenho analisadas foram consumo de ração (g/ave/dia), produção de ovos (%), peso (g) e massa de ovo (g/ave/dia), conversão alimentar (g de ração/g de ovos e kg de ração/dúzia de ovos), casca de ovo (% e g), albúmen (% e g), gema (% e g) e gravidade específica (g/cm^3). O nível de metionina + cistina digestível para codornas japonesas é de 0,696%, que corresponde a consumo diário de 186,7 mg/ave.

Palavras-chave: aminoácidos sulfurosos, produção de ovos, qualidade de ovos

Introduction

Quail breeding for meat or eggs is an activity of considerable economic importance, which always creates new ventures. Thus, it deserves special attention because there are no management and nutrition techniques that meet, in terms of economic and productive efficiency, the ability of the animal to synthesize tissues.

Feeding is the most valuable item in the production cost, and among nutrients, crude protein usually most affects the final price of the diet. By reducing the crude protein level, amino acids levels are also reduced, so that amino acids in the free form have to be used (Silva, 1996). According to Waldroup & Hellwig (1995), the use of synthetic amino acids allows considerable improvements in the economic results.

With increased quail egg production, the nutritional levels of diets have to be corrected, particularly methionine, which in diets based on corn and soybean meal, is considered the first limiting amino acid. A diet containing levels below or above the animal requirements can significantly affect productivity.

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Increased methionine + cystine levels in diets for semi-heavy laying hens significantly improved the egg weight (Togashi et al., 2002) and the level of 0.727% digestible methionine + cystine, with daily intake estimated at 164 mg, improved the productive traits of quails (Pinto et al., 2003). Nutrition data for egg production in Japanese quails are scarce; therefore, values for commercial laying hens are frequently used. Thus, the objective of this study was to determine the digestible methionine + cystine requirements in the diet for better performance and egg quality of Japanese quails.

Material and Methods

The experiment was conducted at the Setor de Avicultura of Departamento de Zootecnia of Universidade Federal da Paraíba, Campus II, municipality of Areia, state of Paraíba, using 240 Japanese quails in the laying phase with initial weight of 180.0 ± 6 8 g, from 94 to 178 days of age, distributed in a randomized block design with five treatments and six replications of eight birds per experimental unit.

In the period from 74 to 94 days of age, the quail egg production was recorded and the egg laying rate was determined to standardize the plots. The birds were separated into categories with similar production intervals (laying percentage), resulting in the following production blocks: 102.5 ± 1.8; 97.1 ± 1.9; 94.3 ± 0.4; 93.4 ± 0.4 and 91.2 ± 1.3%, respectively, for blocks from 1 to 5. With the use of blocks to standardize the plots, the following initial production averages were obtained: 95.8, 95.7, 95.6, 95.7 and 95.8%. The initial average weight of the birds was also considered in addition to the distribution according to production.

The treatments consisted of a basal diet (Table 1) formulated to meet the nutritional requirements of Japanese quail (NRC, 1994), except for digestible methionine + cystine. This basal diet was supplemented with 0.000, 0.061, 0.123, 0.184 and 0.245% of DL-methionine in substitution for corn starch in order to obtain five methionine + cystine levels (0.55, 0.61, 0, 67, 0.73 and 0.79%).

The birds were housed in 33 × 33 × 14 cm galvanized metal cages and received water and feed *ad libitum*. The light program used was continuous light with 24 hours of light (natural + artificial).

Four three-week periods were used, and at the end of each period, feed intake (g/bird/day), egg production (%), egg weight (g), egg mass (g/bird/day), feed conversion per mass (g/g) and per dozen eggs (kg/dozen), albumen weight (g), yolk (g), shell (g), percentages of albumen, yolk and shell and specific gravity (g/cm^3) were evaluated.

Table 1 - Composition of the basal diet on the natural matter

Ingredient	(%)
Corn	56.818
Soybean meal	33.856
Limestone	5.345
Dicalcium phosphate	1.298
Soyabean	1.304
Starch	0.500
Salt	0.478
L-lysine HCl (78,4%)	0.076
L-threonine (98,1%)	0.015
Mineral premix[1]	0.100
Choline chloride 60%	0.100
Vitamin premix[2]	0.100
Antioxidant[3]	0.010
Calculated composition	
Metabolizable energy (kcal/kg)	2.850
Crude protein (%)	20.0
Calcium (%)	2.50
Disponible phosphorus (%)	0.35
Chlorine (%)	0.31
Sodium (%)	0.23
Potassium (%)	0.79
Digestible lysine (%)	1.03
Digestibe methionine + cystine (%)	0.55
Threonine digestível (%)	0.67
Digestible tryptophan (%)	0.22

1 Mineral premix per kg feed: Mn - 60 g; Fe - 80 g; Zn - 50 g; Cu - 10 g; Co - 2 g; I, 1 g; and vehicle q.s.p. - 500 g.
2 Vitamin premix per kg feed: vit. A - 15.000.000 Ul, vit. D3 - 1.500.000 Ul, vit. E - 15.000 Ul, vit. B1 - 2,0 g, vit.B2 - 4,0 g, vit. B6 - 3,0 g, vit. B12 - 0,015 g, nicotinic acid - 25 g, pantothenic acido - 10 g, vit. K3 - 3,0 g, Folic acid - 1,0 g, Bacitracin zinc - 10 g, selenium - 250 mg, antioxidant BHT - 10 g, and vehicle q.s.p. - 1.000 g.
3 Etoxiquim – 10 g; and vehícle q.s.p. – 1.000 g.

At the end of each experimental period, the remains of diets were collected from each plot for feed intake calculation. The eggs were collected twice a day (9 a.m. and 4 p.m.) and the results for the laying of intact and defective eggs and mortality rate were recorded on a frequency card. The egg production percentage was calculated by dividing the number of eggs totaled per plot by the number of birds. The eggs corresponding to the last three days from each experimental period were individually weighed to obtain the average egg weight. The egg mass calculation was obtained by multiplying the egg production by the average egg weight of each experimental unit. The feed conversion per egg mass was calculated by the relationship between feed intake and egg mass produced and the conversion per dozen eggs, by the relationship between food consumption divided by production and the result multiplied by 12.

From the total eggs collected per replication, six units were used to determine the weights and percentages of yolk, albumen and shell. After manual separation of these components, the shells were placed in oven at 105°C for four hours. The percentage was obtained by dividing the weight of these variables by the weight of the eggs and the result was multiplied by 100.

The specific gravity was determined by the saline flotation technique, according to methodology described by Hamiltom (1982), following the principle of Archimedes. At the end of each experimental period, two eggs per plot were visually selected in order to avoid broken or defective eggs. Then, the eggs were immersed in salt solutions with densities from 1.060 to 1.100, with interval of 0.0025. The eggs were placed in buckets with the solutions from the lowest to the highest density, and were taken out when floating, recording the values of densities corresponding to the solutions of each container. Before each evaluation, the densities were checked with a petroleum densimeter.

Data were analyzed by the System for Statistics and Genetics Analysis (SAEG), developed at Viçosa Federal University (1999). Analyses of variance with subsequent polynomial regression analysis were performed to determine the digestible methionine + cystine.

Results and Discussion

Different nutritional levels can affect the overall productivity of birds, represented by performance parameters. The methionine + cystine levels did not affect the feed intake significantly (Table 2), as reported by Sá et al. (2007), who, in a study with methionine + cystine levels from 0.517 to 0.734% in the diet, did not observe the effect of levels of these amino acids on feed intake of light and semi-heavy laying hens. Moreover, Waldroup & Hellwig (1995) used diets with 0.430 to 0.493% methionine + cystine and observed lower feed intake in laying hens receiving the lowest methionine + cystine level.

Although no differences were observed for consumption, increasing methionine + cystine levels were sufficient to affect egg production, egg mass, feed conversion by egg mass and per dozen eggs in a quadratic way, and the average egg weight, in a linear way. The increased methionine levels in the diet improved egg production to the level of 0.668% (Table 3), which may be related to the fact that, despite no significant effect on feed intake, the daily intake of methionine + cystine was 186.7 mg per bird.

Togashi et al. (2002), in research with semi-heavy laying hens, observed increases in feed intake as an attempt to maintain the nutrient levels for egg production. The feed intake of egg-producing quails, in percentage of body weight, is greater than that of commercial laying quails, which makes the amount of feed that the quail consumes and the methionine + cystine levels used sufficient to cause no need to increase the feed intake to maintain the production levels. Furthermore, the increased feed intake is related to the ability of birds to compensate for the deficiency of methionine by increasing intake (Schutte et al., 1994). However, as the deficiency becomes more severe, the feed intake may decrease.

Methionine is the amino acid that starts protein synthesis and furthermore, one of its major paths of action is to act in egg production, influencing egg weight, number and percentage. The methionine + cystine levels promoted increasing linear effect on the average egg weight (Table 2), but the levels used were not sufficient to result in maximum weight. Similar results were observed by Keshavarz (1995), who found higher egg weight with higher methionine levels in the diet. However, Yamazaki & Takemasa (1998) found no difference in egg weight for different levels used.

Considering that the egg mass depends on the production percentage and average egg weight, given in g of egg/bird day, this relationship makes the egg mass extremely important for birds, a hypothesis confirmed by the fact that the need of the animal is directly related to maintenance and production, and thus, the higher the egg production, the greater the need for nutrient intake will be.

The egg mass peak was obtained with 0.696% methionine in the diet, higher than that found for egg production and lower than that obtained for average egg weight, which had linear increase. Low methionine levels reduce the average egg weight and egg mass. However, Keshavarz (2003) observed levels of other nutrients such as choline, vitamin B_{12} and folic acid.

Table 2 - Performance of Japanese quails fed diets containing different methionine + cystine levels

	Levels of methionine+cystine (%)					Efect	CV (%)
	0.55	0.61	0.67	0.73	0.79		
Feed intake (g/bird/day)	27.11	26.77	27.18	26.49	26.65	NS	3.56
Production (%)	86.08	88.42	90.36	87.53	86.30	Q**	2.66
Average egg weight (g)	12.62	13.39	13.44	13.50	13.58	L**	3.47
Egg mass (g/bird/day)	10.86	11.84	12.14	11.82	11.72	Q**	4.56
Feed conversion per egg mass (g/g)	2.499	2.265	2.239	2.245	2.276	Q**	4.86
Feed conversion (kg/dozen)	0.378	0.363	0.361	0.363	0.371	Q*	3.44

NS - not significant; ** Q - quadratic effect at 1% probability; ** L - linear effect at 1% probability; Q * - quadratic effect at 5% probability; CV - coefficient of variation.

Table 3 - Equations estimated for the productive parameters of Japanese quails

Production function	Equation	Set point	R^2
Egg production	$Y = 16.337 + 316.5X - 236.75X^2$	0.668	0.83
Egg weight	$Y = 11.016 + 3.4167X$	>0.79	0.68
Egg mass	$Y = -14.767 + 77.284X - 55.559X^2$	0.696	0.90
Feed conversion per egg mass	$Y = 7.751 - 15.718X + 11.520X^2$	0.682	0.90
Feed conversion per egg dozen	$Y = 0.818 - 1.339X + 0.980X^2$	0.683	0.97

Methionine + cystine levels higher than those found for maximum egg mass impaired the performance of the animal, since the excess of amino acids is not stored and the process to eliminate the excess of nitrogen consumed nutrients and/or energy that would be used in production. Excess methionine impairs performance due to the deamination and nitrogen excretion, which contributes to the excretion of the first limiting amino acid and increases its requirements (Parr & Summers, 1991).

Feed conversion is a direct relationship between feed intake and amount in grams or dozens of eggs produced. Thus, the feed conversion (Table 2) for gram of eggs and for dozen of eggs increased up to the levels of 0.682% and 0.683%, respectively. This increased efficiency was lower than that obtained for egg mass (0.696%) and this can be directly related to the feed intake capacity of animals. However, methionine supplementation in diets to meet the digestible methionine + cystine requirement favors the feed conversion as a result of the balance of amino acids in the diets (Togashi et al., 2002).

When the egg traits were observed, non significant results were found for absolute weight of yolk and shell and relative weight of the albumen and yolk and for specific gravity (Table 4). However, levels above 0.790% had an increasing linear effect on the absolute weight of the albumen (Table 5) and levels below 0.550%, had decreasing linear effects on the relative yolk weight. Furthermore, low r^2 values for the egg traits had a significant effect and it showed the unreliability of the equation obtained. Thus, the data obtained were inconclusive for the effect of methionine + cystine levels on the commercial egg characteristics.

Table 4 - Absolute weight, relative weight and specific gravity of eggs from quails fed diets containing different methionine + cystine levels

Met+Cis(%)	Absolute weight (g)			Relative weight (%)			Specific gravity (g/cm3)
	Albumen	Yolk	Shell	Albumen	Yolk	Shell	
0.55	7.103	3.953	1.021	56.27	31.37	8.099	1.068
0.61	7.817	3.994	1.024	58.39	29.86	7.656	1.066
0.67	7.681	4.125	1.037	57.16	30.68	7.715	1.076
0.73	7.644	4.186	1.030	56.63	30.97	7.632	1.066
0.79	7.833	4.217	1.030	57.72	31.03	7.587	1.068
Efeito	L*	NS	NS	NS	NS	L*	NS
CV(%)	4.221	7.219	4.181	3.062	6.499	3.860	0.854

NS - not significant; L *- linearly to 5% probability; CV - coefficient of variation.

Table 5 - Estimated equations for quality parameters of Japanese quail eggs

Production function	Equation	Set point	R^2
Albumen weight	$Y = 6.176 + 2.148\ X$	> 0.790	0.47
Shell percentage	$Y = 8.909 - 1.747\ X$	< 0.550	0.64

Conclusions

The level of 0.696% digestible methionine + cystine in the diet, corresponding to a daily intake of 186.7 mg / bird, was sufficient to increase the productivity of Japanese quails during the production phase.

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