Effects of dietary glutamine addition on growth performance, carcass characteristics and development of the gastrointestinal tract in Japanese quails

M. SALMANZADEH*, H. AGHDAM SHAHRYAR

Department of Animal Science, Shabestar branch, Islamic Azad University, 53815-159 Shabestar, IRAN

*Corresponding author: salmanzadeh_mehdi@yahoo.com

SUMMARY

The objective of the present study was to investigate the influence of dietary glutamine (Gln) on growth performance, carcass traits and development of the gastrointestinal tract in Japanese quails. A total of 320 one day old male quails were allotted to 5 experimental equal groups in a complete randomized design, according to the added Gln content (0, 20, 30, 40 and 30 mg/kg of diet) for 42 days. Growth performance (evaluated through weight gain, feed intake and food efficiency), carcass traits (relative weights of carcasses, breast, liver and gizzard) and jejunal morphometry (measurement of villus height and width) were determined on day 21 (end of the starting period) and on day 42 (end of the growing period). Weight gains, relative carcass and breast weights were significantly increased in the Gln treated birds compared to the not supplemented controls, particularly in groups receiving 30 and/or 40 mg/kg Gln, depending on the considered period. Food efficiency was also significantly improved in parallel. In addition, the height of the jejunal villus was dramatically increased in birds supplemented with Gln compared to the controls. As a conclusion, dietary Gln supplementation has highly improved the jejunal development, leading to an increased nutrient assimilation and consequently to greater performance in Japanese quails.

Keywords: Japanese quail, glutamine, dietary supplementation, growth performance, carcass, jejunum, villus height.

RESUME

Effets d’une supplémentation alimentaire en glutamine sur la croissance pondérale, la carcasse et le développement du tube digestif chez les cailles japonaises

Le but de cette étude a été d’explorer les effets d’une supplémentation alimentaire en glutamine (Gln) sur la croissance pondérale, les caractéristiques des carcasses et le développement du tube digestif chez la caille japonaise. Au total, 320 poussins mâles de 1 jour ont été aléatoirement répartis en 5 groupes égaux en fonction de la teneur incorporée de Gln (0, 20, 30, 40 et 50 mg/kg d’aliment) pendant 42 jours. Les performances zootechniques (évaluées par le gain de poids, l’ingéré alimentaire et l’efficacité alimentaire), les caractéristiques des carcasses (poids de la carcasse, poids relatifs du blanc, du foie et du gésier) et la morphométrie jéjunale (détermination de la hauteur et de l’épaisseur des villosités) ont été déterminées le 21ème (fin de la période de démarrage) et le 42ème jour (fin de la période de croissance). Les gains de poids et les poids relatifs des carcasses et des blancs ont été significativement augmentés chez les oiseaux traités par la Gln par rapport aux témoins non supplémentés, plus particulièrement chez ceux recevant 30 et/ou 40 mg/kg de Gln selon la période considérée. L’efficacité alimentaire a été significativement améliorée en parallèle. De plus, la hauteur des villosités intestinales a été considérablement accrue chez les cailles traitées par rapport aux contrôles. En conclusion, la supplémentation alimentaire en Gln a nettement favorisé le développement du jéjunum conduisant à une augmentation de l’assimilation des nutriments et secondairement à une croissance pondérale plus forte chez la caille japonaise.

Mots-clés : Caille japonaise, glutamine, supplémentation alimentaire, croissance pondérale, carcasse, jéjunum, hauteur des villosités.

Introduction

Glutamine (Gln) is a non-essential amino acid which plays several roles in the metabolism, e.g. in protein formation. Meanwhile, it is agreed by poultry nutritionists that extra supplementation of non-essential amino acids may also have positive effects on performance. Also, glutamine has a key role in synthesis of nucleotides, amino acids and many other biologically important molecules [17].

Gln is the main energetic substrate for rapidly proliferating cells such as intestinal enterocytes [3] and it has also been reported that glutamine in total parenteral nutrition diets maintains gut integrity [13]. These results are in agreement with the findings of YI et al. [20] who reported that supplementing the diet with 1% Gln increased intestinal villus height in poults. On the other hand, LILJA et al. [12] stated that rapid intestinal growth is a prerequisite for sustained body growth rates in birds. In the study of KATANBAF et al. [10], it was reported that the accelerated growth of the gastrointestinal tract after hatching served the function of a supply organ. These results suggest that dietary Gln supplementation may stimulate development of the gastrointestinal tract and consequently, increase performance of Japanese quails but only some scarce studies on the use of Gln supplementation in poultry diets are available.
It was hypothesized in the present study that increased dietary supplementation with glutamine would benefit to performance, gastrointestinal tract development and to carcass characteristics of Japanese quails. Therefore, the objectives of this study were to investigate the influence of dietary glutamine on performance, gastrointestinal tract development and carcass characteristics of Japanese quails.

**Materials and Methods**

**BIRDS AND PROTOCOL DESIGN**

A total of 320 one day old male Japanese quails were used in the present study. Quails were weighted and randomly allotted to cages such that each cage of quails had a similar initial weight distribution. Birds were kept in cages for 42 days at a temperature which was gradually decreased from 36°C to 24°C. They were divided in 5 equal groups (each group was constituted by 4 replicates of 16 birds per replicate) according to the Gln contents incorporated in the diets (0, 20, 30, 40 and 50 mg/kg of diet). The treatment diets were formulated to meet the NRC recommendations [14] (Table I). Quails had access to feed and water *ad libitum*. All animal experimentation was conducted in accordance with the regulations of Islamic Azad University, Animal Ethics Committee.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Calculated composition (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (g/kg)</td>
<td>240.6</td>
</tr>
<tr>
<td>Soybean meal (g/kg)</td>
<td>420</td>
</tr>
<tr>
<td>Corn protein powder¹ (g/kg)</td>
<td>35</td>
</tr>
<tr>
<td>Soybean oil (g/kg)</td>
<td>15</td>
</tr>
<tr>
<td>CaHPO₄ (g/kg)</td>
<td>7</td>
</tr>
<tr>
<td>Limestone (g/kg)</td>
<td>12.5</td>
</tr>
<tr>
<td>DL-Methionine (g/kg)</td>
<td>0.2</td>
</tr>
<tr>
<td>Lysine (g/kg)</td>
<td>0.3</td>
</tr>
<tr>
<td>VMP² (g/kg)</td>
<td>10</td>
</tr>
<tr>
<td>Sodium chloride (g/kg)</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Crude Proteins</th>
<th>Metabolisable energy (kcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Proteins</td>
<td>240.6</td>
<td>2 847.4</td>
</tr>
<tr>
<td>Methionine</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Methionine + Cystine</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Lysine</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td>5.7</td>
<td></td>
</tr>
</tbody>
</table>

¹Each kilogram contains 550 g of crude proteins and 3.420 kcal; ²VPM: Vitamin Mineral premix supplying per kilogram of diet: vitamin A, 1,650 IU; cholecalciferol, 750 IU; vitamin E, 12 IU; vitamin K₂, 1.04 mg; riboflavin, 5 mg; thiamine mononitrate, 2.04 mg; D-biotin, 15 mg; choline chloride, 4,600 mg; folic acid, 1.03 mg; niacin, 40.20 mg; calcium pantothenate, 11.09 mg; pyridoxine hydrochloride, 3.06 mg; vitamin B₁₂ (cyanocobalamin), 0.3 mg; ZnSO₄ · H₂O, 71.42 mg; FeSO₄ · H₂O, 379.33 mg; CuSO₄ · 3H₂O, 13.08 mg; Na₂SeO₃, 0.46 mg; MnSO₄ · H₂O, 192.53 mg; KI, 0.41 mg.

**Table I**: Composition and nutrient contents of the basal diet distributed to one day old male Japanese quails for 42 days.

In each cage, total quail body weight, quail numbers and the weight of unconsumed and added feed were recorded on days 0, 21 and 42. Mean body weight gains, feed consumption and feed conversion ratios were calculated for each cage (replicate) between 0 and 21 and 22 and 42 days. For each time period, body weight gain was calculated and expressed as grams per bird. Food intake (g of food intake/bird) over the entire grow-out period was calculated by totalling food consumption in each time interval between each bird sampling. Food conversion ratio (g of food intake/g of body weight gain) was calculated by dividing total food intake by total weight gain in each cage.

**RESULTS**

Weight gains and food efficiency were significantly improved in dietary Gln supplemented quails compared to the control quails (p = 0.001 and p < 0.001, respectively). Maximal gains and minimal FCR were recorded in birds supplemented with 30 and 40 mg Gln for the starting period and with 40 mg for the growing period. Weight gains and food efficiency gradually and significantly increased according to the Gln content until these threshold values then they decreased when the added Gln was superior (Table II).

**CONCLUSION**

The relative weights (specific weights to body weight expressed in %) of the carcass and the breast at a lesser extend were also significantly increased in quails supplemented with Gln compared to the control quails (p < 0.05); the highest values were observed in the groups receiving 50 mg and 40 mg Gln.
Dietary glutamine on performance in quails

As far as the intestinal morphology was concerned (Table IV), it was observed that the villus height and width in jejunum were significantly increased (p < 0.001 and p < 0.01, respectively) in the Gln-supplemented quails compared to the controls at the end of the starting period (on day 21). Additionally, villus height and villus width were dramatically increased when the dietary Gln content was above 30 mg/kg and 40 mg/kg, respectively. At the end of the growing period (on day 42), progressive and marked increases in jejunal villus height were recorded in the Gln-treated birds and maximal values were obtained in animals treated with 40 mg/kg of diet whereas changes in the villus width were not

40 mg Gln, respectively. By contrast, the liver and gizzard weights were not significantly altered in the treated birds (Table III).

As far as the intestinal morphology was concerned (Table IV), it was observed that the villus height and width in jejunum were significantly increased (p < 0.001 and p < 0.01, respectively) in the Gln-supplemented quails compared to the controls at the end of the starting period (on day 21). Additionally, villus height and villus width were dramatically increased when the dietary Gln content was above 30 mg/kg and 40 mg/kg, respectively. At the end of the growing period (on day 42), progressive and marked increases in jejunal villus height were recorded in the Gln-treated birds and maximal values were obtained in animals treated with 40 mg/kg of diet whereas changes in the villus width were not
significantly because of the great value dispersion although this parameter has also tended to be higher in treated quails than in the controls.

**Discussion**

Results of the present study showed that growth performance of quails linearly increased with the improved development of the gastrointestinal tract. Therefore, improved growth performance was dependent upon the development of the gastrointestinal tract and the source of Gln used. In agreement, YI et al. [20] reported that the dietary Gln improved the body weight gain and food efficiency and increased intestinal villus height of turkey poults first week after hatch as compared to the control poults. KITT et al. [19] stated that the dietary Gln addition increased intestinal villus height and improved growth performance in weaning pigs. In the study of YI et al. [19], it was reported that improvements in food efficiency had been noted in broilers when they were fed with a diet supplemented in Gln. These results are in agreement with the results of BARTELL and BATAL [2] who demonstrated that the addition of Gln to the diet of broiler chickens stimulates the small intestine development and improves growth performance.

It is well demonstrated that Gln appears to be a conditionally essential amino acid nutrient as exogenous Gln can be a potential candidate in improving intestinal morphology and digestive function [1, 8, 16]. On the other hand, from the conclusions above, it is concluded that the increase in intestinal villus height reported in animals fed with Gln supplemented diets may explain the improvement in growth performance. Therefore, the increased villus height may amplify nutrient absorption and utilisation of nutrients leading to improved growth performance of Japanese quails. In the same way, COATES et al. [5] and IZAT et al. [9] claimed that increase in villus height led to higher performance by improving nutrient absorption. Furthermore, in chickens challenged with coccidiosis, those supplemented with glutamine had higher body weight gains than the control ones [21]. On the contrary, CHEN et al. [4] reported that body weights measured at the 25th day of incubation, at hatch (Day 0), and at the 3rd day post-hatching were not significantly modified in ducks treated in ovo with Gln whereas when they were 7 days old they exhibited a greater body weight than the control ducks.

In the present study, food efficiency as well as the carcass yields and the relative breast weights were also significantly improved in Japanese quails supplemented with Gln. In agreement, DAI et al. [7] showed that dietary Gln supplementation (5 and 10 g/kg) improved performance and carcass characteristics of broiler chickens. Furthermore, in another study, improvement in food efficiency and increases in body weight, weight gain, feed intake, carcass weight and relative weight of breast and thigh were found in broiler chickens supplemented with Gln at 5 g/kg of diet [6].

The present study showed that supplementation with Gln, especially at 30 and 40 mg/kg of food, had a positive effect on growth performance, carcass characteristics and development of the gastrointestinal tract in Japanese quails. Consequently, further studies are needed in order to determine the dietary Gln contents allowing optimal changes in these parameters in Japanese quails and in other bird species.

**Acknowledgements**

The authors have highly appreciated the cooperation of Hassan Rahimi for taking care of birds during the experiment period and helping in the process of experimental work. Also, this manuscript is a part of the research plan of the author.

**References**

DIETARY GLUTAMINE ON PERFORMANCE IN QUAILS


