Chapter 11

Amino Acid for Japanese Quails: Methodologies and Nutritional Requirement

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http://dx.doi.org/10.5772/intechopen.68547

Abstract

The methodologies applied to chickens and laying hens, to determine the digestibility and requirement of protein and amino acids are used with quails, however, they need a more careful evaluation due to peculiarities inherent to the Coturnix genus, in order to provide consistent results. The nutritional requirements of the birds are determinate using the dose-response and the factorial method. Several mathematical models and techniques of diet formulation are allied to the dose-response method in determining nutritional requirements. The curvilinear (hyperbolic) models better portray population behaviour in response to increasing nutrient doses in diets. The reading model, allow a better estimation of the requirement, in relation to the mathematical models used in the dose-response method. The techniques of comparative slaughter and nitrogen balance are effective in determining the nutritional requirements of quails, however, the latter need to be corrected by the loss of nitrogen in the feathers in determining the requirements of crude protein and amino acids for maintenance. The protein-free diet, coupled with the industrial amino acid supplementation, provides more robust digestibility values, since it more effectively predicts the endogenous excretion pattern.

Keywords: amino acids, physiology, Japanese quails, methodologies, requirements

1. Introduction

Created for various purposes (hunting, meat, ornamentation, eggs) the production of quail is a reality worldwide. Countries such as Spain, France, China and the United States stand out for the production of meat, however, when the production is intended to egg production, countries, as China, Japan and Brazil are highlights.

Quail farming in Brazil in the year 2015 reached a total of 21.99 million head, either for meat or for eggs and 447.47 million dozens of eggs [1], which means an increase of 8.1 and 13.9%, respectively, in relation to 2014.

The success of the activity in Brazil is due to the large producing companies that have settled in the territory and to the creation of research groups inserted in Academic Center, with studies directed to the genetic improvement, management and production, and nutrition of quail. The Centers that stand out are: Group of Studies and Poultry Technologies—Federal University of Paraiba, Areia, PB; Nucleus of Fish and Bird Studies—Federal University of Paraiba, Bananeiras, PB; Nucleus of Studies in Poultry Science and Technology—Federal University of Lavras, Lavras, MG. As well as research groups located at the University of Espirito Santo, Alegre—ES, Federal University of Minas Gerais, Belo Horizonte, MG, Maringa State University, Maringa, PR, and Federal University of Viçosa, Viçosa, MG, and the last three groups differ from the firsts, because they also present a breeding program. Worldwide countries such as India, France, Spain and Egypt also stand out with quail research.

[2] World studies on quails date back to 1992, and since 2002 the number of studies in the various research Centers has increased, both in the world and in Brazil. This advance in the Brazilian researches is concomitant with advances in methodologies for food evaluation and nutritional requirements [3, 4], in the knowledge of cellular biochemistry, physiology and animal nutrition, in the development of laboratories in the Research Centers, and in industrial manufacturing of amino acids, premix, etc.

Although of the same family (Phasianidae), commercial poultry, broilers, chickens and quail are of different genres. The latter belong to the genus Coturnix, while the former are of the Gallus genus. Faced with this taxonomic difference, quails have peculiar digestive physiology, and in addition, growth and early reproductive activity, and among others, have low feed intake, which gives them a higher rate of passage in the gastric tract. These differences denote a specific nutritional requirement, mainly protein and amino acid.

Several methodologies applied to chickens and laying hens [4] are effective in quail use; however, they need a more careful evaluation, due to peculiarities inherent to the Coturnix genus, in order to provide consistent results. Another aggravating factor is the lack of quail standard lineages that makes nutrition dynamism even more peculiar with quail. There are few reputable and reputable companies in Brazil that work on quail breeding and provide genetic material for sale. There are few reputable companies in Brazil that work on quail breeding and provide genetic material for sale.

There are two basic methods (dose response and factorial method) for determining the nutritional requirements of birds. However, several mathematical models and techniques for formulating diets that are allied, to the dose-response method, and techniques such as comparative slaughter (CS) and nitrogen balance (NB), used in the factorial model to predict the nutritional requirement values of crude protein and amino acids for birds.

In this chapter, we will discuss the peculiarities of Japanese quails in relation to broilers, laying hens and heavy matrices, and the need to use with criteria, the methodologies to estimate digestibility and requirement, and also review the use of mathematical models, diet formulation and the methodologies of CS and NB.

2. Peculiarities and methodologies

2.1. Peculiarities

Part of the requirements for amino acids and protein for maintenance (laying hens and quail) is directly related to precocity, intestinal gastric tract size (IGT), feather production, development of the reproductive tract, and part of the gain requirement is related to egg weight (inside the same species), and also, rate of muscle deposition (maturity).

Quails, whether intended for laying or cutting, have early maturity and are related to growth rate, and also to size of animals [5, 6], and thus, smaller animals have higher growth rates and lower age to maturity.

Precocity in growth is related to the time the animal takes to achieve sexual maturity, is a guiding parameter in breeding programs, and also denotes different requirements for animals. In this sense, the models that describe growth curves [7–10] validate the premise that each species/lineages and animal category have different nutritional requirements.

Comparing the Gompertz growth curves for Japanese quails [9], meat quails [7, 9], light and semi-heavy laying hens [11] and broilers [8, 10], it is worth mentioning, that between maturity rates (0.720, 0.0594 and 0.0694, 0.0245 and 0.0230, 0.0373 and 0.0411), respectively, and Japanese quails have the highest maturity rate, which refers to higher nutritional needs, protein and amino acids.

Japanese quails have a lower weight of IGT than chickens, laying hens and heavy matrices, but, a higher relative weight in relation to body weight and this factor predisposes a higher rate of passage of the digest by IGT [12–14].

Japanese quail [15] presented weight absolute and relative oviduct of 10.18 g and 3.05%, and ovary of 6.36 g and 2.16%, that are lower in relative to laying hens [16] that presented absolute and relative oviduct weight of 76.98 g and 6.58%, and absolute and relative ovary weight of 36.04 g and 3.08%. However, the relative weight of quail eggs is higher, and may reach 10% of body weight. The weight of eggs of quails has a mean value of 12 g [17–20] and eggs of laying hens around 65 g [21–24].

2.2. Crude protein: methodologies and requirement

The protein and amino acids requirements for quails can be defined by the method of dose and factorial method. The most common is dose-response method and has generated a lot of information's. However, considering the more accurate method, in predicting the requirement of amino acids and crude protein, in this topic of proteins, we will approach a subject only on the factorial model. The approach of the dose-response method will be in the topic about amino acids.

Some studies have been carried out to estimate crude protein (CP) requirements for commercial bird keeping, gain and production using CS and NB techniques.

There studying the requirements of CP for maintenance and gain with Japanese quails in production using the CS technique, [18] obtained the following equation: CP (g/bird/day) = 6.71 × body weight$^{0.75}$ + 0.615 × weight gain + 0.258 × egg mass.

The requirement of CP for maintenance and gain for growing Japanese quails was estimated in the period from 01 to 32 days of age, through the CS technique. The predicted equations were: CP (g/bird/day) = 2.845 × body weight$^{0.75}$ + 0.461 × weight gain for quails aged 01–12 days of age and CP (g/bird/day) = 4.752 × body weight$^{0.75}$ + 0.843 × weight gain for quails in the period from 15 to 32 days of age [25, 26].

The CP requirement for maintenance and gain using the BN technique was determined by the following equation for the 52 week old Lohmann LSL® laying hens: CP (g/bird/day) = 1.94 × body weight$^{0.75}$ + 0.480 × weight gain + 0.301 × egg mass [27].

Using the NB technique to determine the maintenance and gaining needs of Ross® broilers, at 7 days of age of 56, [28] the following equation was obtained: CP (g/bird/day) = 1.323 × body weight$^{0.75}$ + 0.272 × weight gain for males and the following equation for females: CP (g/bird/day) = 1.748 × body weight$^{0.75}$ + 0.277 × weight gain.

Working with 5-week-old Hubbard® matrices, [29] determined the CP (g/bird/day) values for maintenance using the CS and NB techniques, and values their obtained, respectively, were 3.77 and 2.02 × body weight$^{0.75}$, and the mean value for CP requirement for gain was 0.406 × weight gain, for techniques CS.

Working with light replacement pullets, Lohmann LSL®, from the age of 42–63 days, using the CS technique, [30] found CP (g/bird/day) values for maintenance and gain of: 4.7625 × body weight$^{0.75}$ and 0.313 × weight gain.

When evaluating laying hens Hubbard® at age 36–46 weeks of age, [31] estimated the following equation to predict protein requirements: CP (g/bird/day) = 2.282 × body weight$^{0.75}$ + 0.356 × weight gain + 0.262 × egg mass.

It is known that nutritional needs are changed according to species, animal category, room temperature, diet composition and animal density. However, another important factor that changes the nutritional needs is the methodologies used [18, 25–31], such as the CS and NB techniques used in the elaboration of prediction equations.

In an attempt to elucidate the effects of the two techniques in determining PB requirements for maintenance and gain, the values predicted by these two techniques will be compared.

The CP (g/bird/day) requirements for maintenance were predicted by the CS technique, with growing animals, in the studies [26, 29, 30], which, respectively, used: pullets (42–63 days of age), heavy matrices (3–20 weeks of age) and Japanese quails (15–32 days of age). The values are similar between the species, 4.765 and 4.752 × body weight$^{0.75}$ for pullets and quails; however, they are discrepant when compared to heavy matrices 3.77 × body weight$^{0.75}$.

Using the NB technique to determine CP (g/bird/day) requirements for maintenance, the values predicted by the authors, [27, 28, 31], who, respectively, worked with broiler chickens (7–56 days of age), laying hens, and heavy matrices, were: 1.323; 1.94 and 2.28 × body weight$^{0.75}$. It can be observed that there is no similarity between the all determined values. However, the values are consistent when analyzing animals in the same category [27, 31] which were: 1.94 and 2.28 × body weight$^{0.75}$.

It can be observed that the net requirement of CP (g/bird/day) for gain, determined by the two techniques (CS and NB) and reported in the works of [18, 25–31], is, respectively: 0.615; 0.461; 0.843; 0.480; 0.272; 0.406; 0.313 and 0.356 × weight gain. Comparing the requirements of CP (g/bird/day) to gain, with the CS technique, the values are: 0.406; 0.461; 0.615 and 0.843 × weight gain. Those predicted in the NB technique are: 0.272; 0.356 and 0.480 × weight gain.

A relevant comparison is to analyze the same technique and animal's age, growth and posture. Within the CS technique, with growing animals, the values were: 0.313; 0.461 and 0.843 × weight gain, respectively, pullets (42–63 days of age), quails (01–12 days) and quails (15–32 days of age). In NB technique for growing animals, the values were, respectively: 0.272 × weight gain, for broilers; and for the animals in posture were: 0.356 and 0.480 × weight gain, respectively for, laying hens and heavy matrices.

The values of requirement of CP (g/bird/day) estimated for egg mass production in laying hens and Japanese quails were, respectively, 0.301 × egg mass [26], and 0.258 × egg mass [18]. However, the first one presents a lower requirement of amino acids and CP, evidencing that the greater requirement of quails is related to the higher maturity rate, that is, higher precocity [9–11]. Corroborating the findings of [18, 25–27, 29], where these authors found a requirement of CP for greater maintenance and gain for Japanese quails in relation to laying hens and heavy matrices.

It is clear from the aforementioned works that the CS and NB techniques used to determine PB requirements for maintenance and gain provide conflicting, inter and intraspecific values, which makes comparison difficult. In an attempt to elucidate this difference between the methodologies, [32] described the potential of nitrogen retention in laying pullets by analyzing the two techniques: CS and NB. The authors describe that excreted nitrogen measured in the BN technique does not seem to contain all possible physiological effects, except for amino acid oxidation, in relation to the CS technique. This factor suggested by the authors seems to be the accounting for the nitrogen lost in feathers (NF), which is not measured when used in the NB technique, and with that, the CP requirement values for maintenance between the two techniques are more discrepant.

For [33], the use of the BN technique is even more aggravating, because in this technique, diets are formulated with different levels of protein to generate deficiency and excess CP in the animals' diet. In this sense, the relationship between the protein level and the loss of NF was established, described by the equation $NF = 0.3007 + 0.0086\,N$, where, for each gram of increase in the nitrogen concentration of the diet, there was a loss of 8.6 mg of nitrogen in feathers, that is, the deficiency in proteins leads to less deposition of amino acids in the feathers, thus, changes the requirement of maintenance the animals. [34] Also verified the influence of nitrogen losses on feathers on the need for maintenance, using the BN technique.

Using the correction value of nitrogen losses in the feathers found by [33], [32] in their work using this correction could conclude that differences between CP needs for maintenance between the two techniques, CS and NB, decreased fell from of 1.56: 1 for 1.28: 1, comparing CS: NB.

2.3. Amino acids: methodologies, digestibility and requirement

The requirements of amino acids have been described by two methodologies: empirical and factorial method [4]. To evaluate the nutritional requirements in the dose-response or empirical method, the diets are formulated with increasing levels amino acid, gradually, and observed the response of the animals through polynomials (linear and quadratic), broken line and hyperbolic and analyzed in order to estimate the requirements of birds. In the factorial method, the requirements are described in function of the maintenance, growth and production, and relate to the metabolic weight, weight gain and eggs mass production. This method was described in the topic of proteins.

In addition to the methodologies, there are also techniques for formulating diets that also change the requirements. One of the techniques consists of gradual increases of the nutrient tests [35], the other prioritizes the dilution of the diets, which consists of formulating a diet free of the test nutrient and another diet with the same nutrient in excess, and the nutrient levels studied will be obtained by the dilution of the two diets [36].

The success in determining the requirements is a thin line, that is, the robustness of the proposed models and determined requirement are allied to the knowledge and interpretation of each physiological factor of the animals, and mathematical model, in order to promote satisfactory performance to birds.

2.3.1. Amino acids methodologies: techniques for preparing diets

In the technique proposed by [35], the supplementation of a single amino acid generates imbalances in the relations between amino acids and amino acids/lysine. This point is crucial, since it refers to the ideal protein concept proposed by [37], where the diet needs to have an optimal balance of amino acids to provide maximum performance to the animals with lower nitrogen excretion.

The supplementation technique is widely used [38–45] and has generated a large number of discrepant nutritional information. The main factor is the imbalance between amino acids. The main antagonist relationships between amino acids are: arginine and lysine and the relationship between leucine, isoleucine and valine.

The excess of lysine in the diets, when using the technique proposed by [35], to assessing the lysine requirements, promotes an increase in serum lysine levels, and consequently, a greater loss of arginine by renal catabolism due to the increase in enzyme arginase [46], and generating confusion in the determination of the optimal levels of lysine.

Ref. [45] evaluated different levels of digestible arginine in the diet of Japanese quails, with diets formulated by the supplementation technique, estimated an ideal dietary arginine level of 1.148% in diets with 1.083% digestible lysine and relation arginine/lysine of 1.06.

Refs. [47, 48] evaluated the requirement of digestible lysine with Japanese laying quails, using the supplementation technique, but these authors maintained the relationships between the amino acids of the diets. The authors found digestible lysine levels of 1.117 and 1.120%, respectively, in diets with arginine/lysine ratios of 1.26 and 1.16, respectively.

Ref. [17] found levels of digestible lysine for Japanese quails in production of 1.030% in diets formulated by the supplementation technique and without correction of the arginine/lysine ratio.

The Brazilian Poultry and Swine Table [49] and the Table for Japanese and European Quails [50] present, respectively, digestible lysine values of 1.083 and 1.030% and digestible arginine of 1.256 and 1.260%, respectively, with arginine/lysine ratios of 1.16 and 1.22.

Looking at the data, mentioned above, it is evident that the imbalance of the diets promotes different results among the authors [17, 47, 48]. However, [47, 48] found values equal, but maintained the relationship between the major amino acids; however, this practice of supplementing all amino acids to maintain relationships raises the cost of formulating diets.

Another known, but poorly studied amino acid relationship is branched-chain amino acids (isoleucine, leucine and valine). These three amino acids compete for the same intestinal transporter and for the same enzymes in cell metabolism [46].

When applying the concept of protein reduction and ideal protein, the basal diets composed of corn and soybean meal have increased maize levels, with this there is an increase in dietary leucine levels in relation to isoleucine and valine. Excess leucine [46] in the diet depresses the use of valine and isoleucine by animals, decreasing their performance.

Ref. [51] observed that high concentrations of isoleucine and low levels of valine and leucine affected the performance of laying hens in the laying phase. This same effect was verified by [52] when evaluating valine/lysine and isoleucine/lysine relations for Japanese quails in production. The author recommends relations, respectively, of 0.75 and 0.82, for isoleucine and valine.

Analyzing the diets [52] of experiment I, where valine/lysine relations were evaluated, and the level of isoleucine in the diets was 1.0%. In experiment II, where the ideal isoleucine/lysine relations was verified, the level of valine in the diets was 0.75%, the latter was determined in experiment I. The higher levels of isoleucine (1.0%) used in the diets of experiment I, may have promoted lower performance in the animals, even in diets with higher levels of valine (0.75, 0.80, 0.85, 0.90, 0.95 and 1.05%).

This assumption is found in Experiment II, where the ideal level of isoleucine was 0.82%, when the diet contained 0.75% valine, indicating that excess isoleucine (1.0%—in experiment I) affected performance of the birds, not allowing to verify improvement, even with higher levels of valine, or even the level of 0.82% of isoleucine that promoted the best performance the birds was limited to the value of 0.75% valine in the diet, since in experiment II levels of isoleucine were of 0.65, 0.70, 0.75, 0.80, 0.85 and 0.90%, corroborating the findings of [51]. In addition, in both experiments (I and II), the diets contained near levels of leucine, respectively, 1.597 and 1.537%.

Aiming to understand the relationship between valine/isoleucine and recommend the best level of valine and isoleucine in the diet of Japanese laying quails [53], proposed the following methodology. In experiment I, were studied valine levels of 0.74, 0.81, 0.88, 0.95 and 1.02%, with fixed level of isoleucine (0.70%). In experiment II, the same levels of valine were evaluated, now, with different levels of isoleucine (0.64, 0.70, 0.76, 0.82 and 0.88%). The author recommends valine levels of 0.74 and 0.64% of isoleucine in the diet of Japanese quails in production. In addition, the leucine level used in both experiments was 1.47%.

It is noteworthy that the interpretations of the results of [53] do not repeat with those of [52], and these findings show that there are other factors involved in the study of the relationship between branched chain amino acids, intestinal transporters and metabolic enzymes, and which have not yet been described.

Comparing the two techniques of diet formulation [54], in his work proposed to study the technique of supplementation and dilution of diets, and to evaluate the levels of digestible lysine for broilers from 01 to 42 days of age. The author suggests the most appropriate dilution technique to formulate the diets, since it promotes better performance to the animals, and this technique reduces the use of supplemental amino acids to maintain the relationship between amino acids, since many of them have high cost of supplementation.

2.3.2. Amino acids methodologies: requirement

The two methodologies used to evaluate the amino acid requirements for poultry are the empirical method and the factorial method, and have as diet formulation techniques, supplementation and dilution, discussed above. In this topic, we will address the methodologies, specifically the dose-response method, since the factorial method has already been described in the topic on proteins.

In the empirical method, the requirement is determined through the addition of the nutrient test in the diets. The levels studied should promote a response curve where they can observe deficiency, gain, stability and toxicity [55]. The response curve can be interpreted by several mathematical models [4], and the choice of them can change the value of the animal requirements.

The models used are: first and second degree polynomials, the broken line model and exponential.

The first polynomial models and the interrupted line model describe the linear performance of the animal due to the addition of nutrients. In addition, the interrupted line model predicts that, from a given level of nutrient supplementation, there is no effect, establishing whether a plateau, where the requirement is determined by the intercept of the line with the plateau. In the first model (first-degree polynomial), there is no predict an optimal level, but only data behavior, increasing or decreasing, and it is not possible to infer whether the behaviors of the line will be kept at lower levels or higher doses high.

The description of the behavior of the data in a linear way is the premise of the response of a single animal however, the population response pattern tends to be curvilinear, since the animals have different responses, even those of the same genetics and age [56], and thus, linear models do not accurately predict the requirements of animals.

The quadratic model presents an advantage in relation to the two models already mentioned, since the answer is curvilinear, describing the population pattern; however, in this model, the optimum point tends to be in the middle of the points studied, since there is a tendency of symmetry between the points to generate the response curve, so the authors work with the estimated value of 95% as the requirement of the animals.

For [57, 58], the models used to predict the requirements must have biological and mathematical meaning.

Nonlinear models predict that the animal's response tends to decrease as it reaches maximum performance or asymptotic point. However, in this type of model, the exponential, the maximum performance would never reach, that is, it never reaches the asymptotic point, so, the authors suggest assigning a percentage ranging from 95 to 99% of the asymptotic response [4] as being the requirement of the animals.

Several are the works that use the empirical method to determine the requirements of amino acids with Japanese quail, using the most diverse mathematical models. The choice of model should be judicious, and the model should most accurately describe the animal's response.

For [59] the linear, polynomial and exponential models, within their limitations, present good adjustments; however, the answers are varied, with this, there is indecision about the best to be recommended level. In this way, [59–61] propose the use of the reading model in an attempt to overcome the indecision generated in the choice of the mathematical model to estimate the nutritional requirements of amino acids, since this model allows a better interpretation of the behavior of the population in function of the levels studied.

Ref. [62] reviewed the reading model and noted that it would allow better estimation, in relation to the mathematical models used in the dose-response method. However, other factors that affect nutritional requirements such as temperature and type of lodging are not possible to include in the model.

As previously reported, the factorial method, described in the topic on proteins, is considered the most appropriate, since in this methodology, it is possible to fractionate the requirements in maintenance, gain and production, and it is possible to add other factors such as temperature, etc.

The mathematical models of prediction with amino acids resemble their construction, with the models already described in the topic on protein, through the factorial method. All peculiarities inherent to quails in relation to broilers and laying hens need to be weighed in the construction of the prediction equations for amino acids.

Due to the scarcity of work in these molds for Japanese quails, and especially with amino acids, no research data will be presented for comparison and elucidation of the techniques, since the premises discussed in the models of protein requirements are the same.

The Brazilian Poultry and Swine Tables [49] indicate the lysine requirements for Japanese quails in posture by the factorial method, but are approximate data of other species.

2.3.3. Amino acids Methodologies: digestibility

The digestibility of the amino acids can be influenced by the physiology of the animal and the technique/methodology used. The digestibility is measured by comparing the amount of amino acids present in the test feed, and the intake of the same by the animals and the difference of what are recovered in the excreta.

Quails have a higher relative weight of large intestine in relation to broilers and laying hens. In the large intestine of the animals, there is microorganism that ferments the cecal content and with this can contribute to cecal production of amino acids and or nitrogen, underestimating the digestibility of the amino acids and altering the nitrogen balance. In this sense, quails would present values of amino acid digestibility, less than roosters, laying hens and broilers [63, 64] and allied to this factor, the greater passage rate would contribute to greater escape of protein/amino acids to the large intestine, greater amino acid excretion and fecal nitrogen, further underestimating the results.

To avoid increased cecal amino acid production, ileal content collection, cecectomy, and accurate feeding techniques are suggested to predict amino acid digestibility [49, 50, 65–67]. In addition, fasting [65], used in the precise feeding technique, is criticized by several authors, since fasting animals have patterns of endogenous loss of amino acids different from fed animals. Values of digestible amino acids determined with quails and using the above techniques are scarce.

Using the precise feeding technique, with intact and cecectomized roosters and intact Japanese quail, [68] studied the amino acid digestibility of different foods (maize, low tannin sorghum) and verified that the digestibility of amino acids with cecectomized roosters is greater in relation to intact roosters for most of the amino acids present in maize, with the exception of the amino acids: cystine, threonine, arginine and histidine. The digestibility of the amino acids present in the sorghum did not change due to the cecectomy, except for methionine, where the cecectomized roosters had a higher value. When comparing quails with intact roosters, the authors concluded that the digestible amino acid values with quails are larger, analyzing the corn, but with sorghum, there was no difference except for the amino acid histidine.

Although the authors [68] did not present statistical data comparing the amino acid digestibility values of cecectomized roosters and quails, in absolute values, for maize, the data presented similarities, but when comparing sorghum, values with Japanese quails showed the lower digestibility values. For the amino acid proline (2% points) and histidine (36% points), the other amino acids on average the difference were around seven percentage points less in the digestibility values for quails. These data for maize suggest that although quails have proportionately larger ceca, this factor did not interfere with digestible amino acid values. Another important factor is that using digestible amino acid values of intact roosters for quails is not recommended.

Some authors [69, 70] have suggested, respectively, some methodologies to stabilize the endogenous loss of amino acids by the animals, such as protein-free diet (PFD) and enzymatically hydrolyzed casein (EHC) techniques.

All these methodologies were worked with broilers and laying hens, and several authors criticized their use [71, 72]. However [73] suggest the PFD technique associated with amino acid supplementation, as being the one that best estimates the endogenous loss of amino acids by birds.

Studies evaluating these techniques with quails are scarce, especially those that evaluate the EHC and PFD and PFD techniques associated with industrial amino acid supplementation, as well as the technique of cecectomy and collection of ileal content.

The above-mentioned propositions suggest that formulating diets based on recommendations of digestible amino acids determined with intact and cecectomized roosters is not recommended for Japanese quails and should make considerations about the digestive physiology of quails, as well as the methodologies described. In quail nutrition, there are rare papers describing mathematical models to predict the requirement for amino acids.

3. Conclusions

Quails present physiological and behavioral peculiarities in relation to laying hens, heavy matrices and broilers. The differences between species of industrial poultry are premised to develop specific feeding programs for each species, lineage and animal category.

The nitrogen balance and comparative slaughter technique provide discrepant data, but are more consistent and close when the correction factor for nitrogen deposited in feathers is used.

The mathematical models used to describe nutritional requirements, in dose-response method, must be used with discretion, since the ideal model must have not only mathematical meaning but also biological meaning.

Prediction equations developed with broilers and laying hens should not be used to predict the protein and amino acids requirement for quails, should developing models appropriate for the each species, and animal category.

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