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# APPLICATION OF DIFFERENT LEVELS OF PROTEIN AND SYNTHETIC AMINO ACIDS IN THE PRODUCTIVE BEHAVIOUR OF QUAILS

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*— Abstract—*

The effect of different levels of crude protein (PB) added with synthetic amino acids (AAS) on the productive behavior of laying quail was evaluated. 500 quail were used, which were randomly distributed to four treatments according to a completely randomized design with five repetitions T1: 21% PB + 0.15% AAS, T2: 20% PB + 0.19% AAS, T3: 19% PB + 0.22% AAS and control treatment T0: 22% PB. The results showed that the best consumption of nutrients was obtained in quails fed with T2 (P <0.01), for the variables: Dry matter (22.31 g / day); Metabolizable energy (0.07 Mcal/Kg); Lysine (0.27 g/day); Methionine (0.08 g/day); Threonine (0.15 g/day). The highest consumption of PB was with T1 (P <0.01) with 4.61 g/day. The best productive performance of quail was obtained with T2 with 83.69% of egg production. The T2 was adjusted to a third-order linear model (P <0.01) and it was found that the production percentage will depend on 66.90% of the protein levels with 10.75 g, as the average egg weight, 9, 00 g total egg mass and 0.80% mortality. A slight increase in the transverse diameter was observed for the morphology of the T2 egg (P <0.01) with 26.10 mm. The best Benefit/Cost ratio was with animals in T2 and $1.30 was obtained. Synthetic amino acids with low PB levels improve productive behavior in laying quail.

**Keywords**

*Quail production, Bird feeding.*

Poultry farming emerged as a complementary activity to agricultural systems, in which birds were fed with seeds from crops and natural foods taken from their environment (worms, earthworms, etc.) (Pitakpongjaroen & Wiboonpongse, 2015), while diseases were treated based on traditional knowledge (Syakalima, Simuunza & Zulu, 2017). In turn, birds reduced some farm pests, fertilized the land with manure, and contributed meat and eggs to the family diet (Tovar, Narváez & Agudelo, 2015).

In Ecuador, the poultry industry began during 1950 and 1960, and in recent years improvements have been made in the genetics of breeds for fattening and feeding (Orellana, 2014). The genetic lines used by Ecuadorian companies in chicken production are Cobb and Ross (Ruiz, 2016). Quail is the smallest species exploited in the commercial poultry sector (Panda & Singh, 1990). The reason for its success is explained by the high level of production and the nutritional quality of the egg, which has allowed its acceptance in the market (Iqbal *et al*., 2015).

The breeding of quail (*Coturnix coturnix japonica*) is a high-performance poultry activity. The low initial investment, the few requirements of land spaces, the fast return of capital, the nutritional value of meat and eggs, the low cost of production, the high production level; the fast growth, the rusticity and the precocity of this species, are some characteristics that make the product attractive and turns it into an alternative source of nutrients with the egg production (Ciriaco & Roncal, 2016).

The Japanese quail has generated great interest among poultry farmers dedicated to egg production in Ecuador since it requires little economic investment for its breeding (Özsoy & Aktan, 2011). Therefore, the objective of this study is to evaluate the amount of crude protein plus synthetic amino acids and their response to the productive behavior of laying quail.

## MATERIALS AND METHODS

### *Location of the area of study*

The present research was developed in the quail farm "Reina del Quinche" located in the parish Veloz, canton Riobamba, province of Chimborazo, Ecuador, which lasted 120 days. The bromatological analysis of the diets used was carried out in the laboratory of the National Institute for Agricultural Research (INIAP).

### *Experimental Units*

The number of experimental units was 500 quails, which were randomly distributed in four treatments and five repetitions per treatment, with an experimental unit size of 25 birds.

*Treatment and experimental design*

The experimental treatments were crude protein (PB) levels plus the amount of synthetic amino acids (SAA): T1: 21% PB + 0.15% AA; T2: 20% PB + 0.19% AAS, T3: 19% PB + 0.22% AAS, T4: 22% PB (control treatment) A completely randomized design was used, with the following additive linear model:

$$y_{ij} = \mu + \tau_i + \varepsilon_{ij}$$

Where:
$y_{ij}$ = Observation in j-th repetition i-th level of crude protein

$\mu$ = General average

$\tau_i$ = Effect of the i-th level of crude protein (19, 20, 21, 22%)

$\varepsilon_{ij}$ = Experimental error

*Statistical analysis and significance tests*

The numerical field and laboratory results determined in this research were processed using the statistical program SPSS (version 18) and Excel 2013 (Microsoft Office®), performing the following statistical analyses: Analysis of variance, analysis of correlation and regression, and separation of means using Waller Duncan's test with a significance level of $P < 0.05$ and $P < 0.01$.

*Experimental Procedure*

The area of study was disinfected with AQUAT 50 (Quaternary Ammonium Compound 20%) at a rate of 1 ml per liter of water, which was applied by backpack spray, seven days before the reception of the quails. Iodine was applied for the asepsis of feeders and drinkers in doses of 2 ml per liter of water, four days before the arrival of the birds.

All quails were given water with electrolytes plus vitamins to reduce transfer stress. At the second week of reception of the birds, feed consumption was evaluated and production was estimated in percentage. The first seven days were considered a critical period for offering the adaptation diet.

All birds were weighed daily and placed in the linear feeders. All of them were offered 25 g of bird food/day and water *ad libitum* through automatic cup-type drinkers, to which vitamins were added to reduce stress during waking. This handling practice was carried out after 15 days of permanence, and electric caution, iodine, and vitamins were used. Every two months the mixed vaccine against Newcastle and infectious Bronchitis was applied in the eye, to lower the bacterial load iodine nebulizations were performed twice a week, and to avoid the attack of fungi, they were given 1 ml of iodine per liter of water once a day.

Egg production was quantified daily and was done twice a day (8:00 am and 5:30 pm) with a plastic basket. For this, they were offered 14 hours of natural or artificial light, the electric power was activated from 6:00 to 10:00 pm.

A thermometer was used to control the temperature between 18 and 22°C and to avoid airflow the curtains were handled to create a microenvironment. The place was cleaned with a shovel and broom every 15 days to reduce the accumulation of ammonia and not to affect the birds' respiratory tracts. A layer of lime and rice husk was spread on the floor (Salinas, 2015).

## RESULTS AND DISCUSSION

### *Nutrients intake*

### **Total feed intake**

Total feed consumption in laying quails with different levels of protein plus synthetic amino acids was different ($P<0.01$), the lower consumption was obtained with T1 (Table 1). Daily feed consumption was different ($P < 0.01$). The highest daily consumption of feed was recorded in quails treated with T2, T0, and T3; and the lowest consumption with T1 (Table 1).

**Table 1**

*Nutrient intake in laying quails treated with synthetic amino acids with low levels of crude protein in the diet*

| VARIABLES | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| | T0 | T1 | T2 | T3 | SE | Prob. |
| Total feed intake, kg | 2,34 a | 2,25 b | 2,34 a | 2,33 a | 0,0063 | 0,001 |
| Feed intake, MS g/day | 22,29 a | 21,43 b | 22,31 a | 22,20 a | 0,0629 | 0,001 |
| Crude protein intake, g/day | 4,03 d | 4,61 a | 4,48 b | 4,38 c | 0,0141 | 0,001 |
| ME intake, Mcal/day | 0,07 a | 0,06 b | 0,07 a | 0,07 a | 0,0007 | 0,002 |
| Calcium intake, g/day | 0,81 a | 0,80 ab | 0,78 b | 0,71 c | 0,0024 | 0,001 |
| Phosphorus intake, g/day | 0,12 b | 0,11 c | 0,11 c | 0,13 a | 0,0006 | 0,001 |
| Lysine intake, g/day | 0,20 c | 0,23 b | 0,27 a | 0,23 b | 0,0007 | 0,001 |
| Methionine intake, g/day | 0,06 c | 0,06 c | 0,08 a | 0,07 b | 0,0008 | 0,001 |
| Threonine intake, g/day | 0,11 c | 0,13 b | 0,15 a | 0,13 b | 0,0004 | 0,001 |

Same letters do not differ significantly according to Waller Duncan ($P <0,05$ and $P <0,01$).
SE: Standard error.
Prob: Probability.
ME: Metabolizable energy.

Source: Own elaboration

Regarding these results, Tapia (2010) registered consumption of 22.33 g/bird/day and total consumption of 2.74 kg. Hurtado, Torres & Ocampo (2013) concluded that protein directly interferes with the consumption of feed per bird, by increasing or decreasing its percentage within the ratio, according to the total kcal offered.

**Crude protein intake**

Protein consumption in quails treated with synthetic amino acids in the present research showed statistical differences between treatments (P <0.01). The highest consumption was recorded with T1 and the lowest consumption with the control treatment (Table 1). These results are lower than the average obtained by Yamane, Ono & Tanaka (2007), and Portillo (2005) with averages of 4.9 g/day and 5.47 g/day in their respective order varying according to food consumption and the percentage of protein in the diet. Similarly, Begin & Insko (1994) determined that 4.71 g/day is required when the posture rate is 78% to 80% with a diet of 21% to 22.9% of protein and 2600 Kcal/kg ME.

**Energy intake**

T1 birds had the lowest average of ME consumption, which differs (P <0.01) from the rest of the treatments (Table 1). These values match with those reported by Yamane, Ono & Tanaka (2007) who obtained normal parameters with consumption of 0.062 Mcal/day.

Labier & Leclercq (1992) found daily necessities of 0.082 Mcal/day for quails with an average weight of 220 g and showed that the energy level influences the conversion rate and egg mass.

**Calcium intake**

Averages of calcium consumption showed differences (P <0.01). The lowest consumption was recorded in quails treated with T2 and T3 (Table 1). These results surpass those found by Shrivastav & Panda (1999) who stated that for laying, 550 mg to 650 mg/quail/day of calcium consumption are necessary, equivalent to 0.55 to 0.65 g/day depending on the bird's weight, which can vary from 140 to 220 g and the daily egg mass of 9 or 10 g. Similarly, these data exceed the results presented by Labier & Leclercq (1992) with an average of 730 mg of calcium consumption corresponding to 0.73 g/day.

**Phosphorus intake**

Differences were found for phosphorus consumption (P <0.01). The highest consumption was recorded in quails with T3 and the lowest consumption with the T1 and T2 (Table 1). Phosphorus consumption obtained in this research is higher than those registered by Shrivastav & Panda (1999) and lower than those reported by Labier & Leclercq (1992) where averages of 0.055 and 0.15 g/quail/day are reached. Shrivastav & Panda (1999) mentioned that the ratio of calcium and phosphorus in poultry rations or feeds is known as calcium/phosphorus ratio, which for quails in production, is 4:1, which differs from the one reported in the present research, the calcium/phosphorus ratio was 6:1 for T0; 7:1 for T1 and T2; and 5:1 for T3.

**Lysine intake**

Daily lysine consumption per bird was different (P < 0.01). The highest consumption was recorded with T2 and the lowest consumption with the control treatment (Table 1).

Oliveira *et al.* (1999) tested two levels of crude protein in the ratio (19.0 and 14.1%) supplemented with five levels of lysine (0.65; 0.85; 1.05; 1.25 and 1.45%) and concluded that the best weight and highest egg production was achieved with 1.05% lysine and 19% crude protein. The authors explained, that due to the low protein content of the serving, catabolism increased and the amino groups of the protein were diverted for the synthesis of non-essential amino acids or uric acid.

**Methionine intake**

Quails' methionine intake was different (P < 0.01). The highest methionine consumption was recorded with T2, and the lowest consumption with the control treatment and T1 (Table 1). The highest consumption obtained in this research is equal to the consumption of methionine achieved by Yamane, Ono & Tanaka (2007) who indicated that the optimal production without impairing the rate of consumption is achieved with a daily intake of 0.08 g/bird/day.

**Threonine intake**

The threonine intake showed differences (P <0.01). The highest consumption was recorded with T2 and the lowest consumption with the control treatment (Table 1). The above results exceed those found by Yamane, Ono & Tanaka

(2007) which indicate that production is not affected by a daily intake of 110 mg of threonine equivalent to 0.11 g/day/quail with diets of 22% protein.

Threonine's toxic effect on food is considered little or null since it is easily metabolized by the body, as well as its derivative compounds. Therefore, histidine, tryptophan, and methionine are not considered an amino acid of toxicity (Castañón, 1994).

*Productive behavior*

**Weight at the beginning of laying**

In the analysis of variance of the weight of the quails at the beginning of laying, the best treatment was the control treatment with 181.44 g, while T1 was lower with 174.92 g, for T2 a value of 173.21 g was obtained, and the last was T3 with 168.68 g (Table 2). Results which, when compared with Ortega (2011) in his study on the determination of the effect on different microenvironmental temperatures in the initial phase, growth, development, and laying in quails, reported weight at the beginning of laying of 170.74 g, lower results than those found in the present investigation.

**Final weight**

The analysis of final weight variance did not register statistical differences ($P > 0.05$), so the averages were 196.84; 195.44; 195.24 and 192.23 ± 1.4978 g corresponding to T1, T0, T3, and T2 respectively see Table 2.

According to the results obtained during the research period, when compared with the values found by Ortega (2011) and Obregon (2012), they show inferiority since they registered pesos of 208.84 and 201.04 g.

**Percentage of quails in production**

The percentage of production presented statistical differences ($P < 0.01$), where the percentage of production in quails treated with T2 presented the greatest average with 83.69% followed by quails fed with T3 and T0 with 79.13% and 78.51% of production in their respective order and with a lower percentage of egg production was recorded in quails treated with T1 with 75.27% with a dispersion for each average of ± 0.4724 % (Table 2).

Hurtado *et al.* (2013) in their study on the effect of protein levels on the performance of Japanese quails in the laying phase, obtained the highest percentage in quails fed 20.5% PB and 2850 Kcal/Kg with an average of 84.69% while the lowest percentage was obtained with diets whose protein was 22% and 3050 Kcal/Kg with an average of 79.23%, results which are corroborated by this research.

## Total egg mass

Significant differences were registered (P<0.01) for this variable, being the highest response in T2 birds with an average of 9.00g, followed by the control treatment with 8.46g, finally the T3 and T1 treatment that shared significance with averages of 8.38; 8.07 g and with a dispersion for each average of ± 0.0555 g (Table 2).

The results obtained in this research exceed those found by Moura *et al*. (2009) and which is also lower than those found by Ortega (2011) with averages of 8.09 and 10.72 g.

## Mortality rate

The analysis of variance for the percentage of mortality in the production phase did not report statistical differences between the means of the treatments (P>0.05) however numerically the lowest percentage of mortality was for T2 with 0.80% followed by 1.60% for T1, and sharing the same range T0 and T3 with 2.40% having a dispersion for each mean of ± 0.5797% as shown in Table 2.

**Table 2**
*Productive behavior of laying quails treated with synthetic amino acids with low levels of crude protein in their diet*

| VARIABLES PRODUCTS | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| | T0 | T1 | T2 | T3 | SE | Prob. |
| Weight at the beginning of laying, g | 181,44 a | 174,92 a | 173,21 a | 16,68 a | 1,3464 | 0,057 |
| Final weight, g | 195,44 a | 196,84 a | 195,23 a | 192,24 a | 1,4978 | 0,801 |
| Birds in production, % | 78,51 b | 75,27 c | 83,69 a | 79,13 b | 0,4724 | 0,001 |
| Total egg mass, g | 8,46 b | 8,07 c | 9,00 a | 8,38 bc | 0,0555 | 0,001 |
| Mortality rate, % | 2,40 a | 1,60 a | 0,80 a | 2,40 a | 0,5797 | 0,790 |

Same letters do not differ significantly according to Waller Duncan (P <0.05 and P <0.01).
SE: Standard error.
Prob: Probability.

Source: Own elaboration

However, Amarrilla & Albornoz (2013), reported that mortality in the laying stage should not exceed 4%, while for birth and development it should be 10% and for birds whose purpose is fattening it should be 5%.

Similarly, these results are lower than those found by Obregon (2012) who, in his study on the use of different levels of natural hibotek growth promoter in the breeding, development, and raising of quails and its effect until reaching production peak, achieved 10% mortality. This is given to the addition of threonine in the diets since this is important in the humoral immune response since it is necessary for the formation of the hypervariable regions of the immunoglobulins or antibodies.

*Egg structure evaluation*

**Egg weight**

No significant differences were reported in the egg's weight (P>0.05), being 10.78, 10.75, 10.72, and 10.60 ± 0.04374 g for T0, T2, T1, and T3 treatments respectively. (Table 3).

**Table 3**
*Evaluation of quail eggs components treated with synthetic amino acids with low levels of crude protein in the diet*

| EGG STRUCTURE | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| | T0 | T1 | T2 | T3 | EE | Prob. |
| Egg weight, g | 10,78 a | 10,72a | 10,75 a | 10,60 a | 0,0434 | 0,571 |
| Shell weight, g | 1,51 a | 1,48 a | 1,43 a | 1,47 a | 0,0110 | 0,168 |
| Yolk weight, g | 3,58 a | 3,54 a | 3,62 a | 3,53 a | 0,0268 | 0,714 |
| Albumen weight, g | 5,69 a | 5,70 a | 5,71 a | 5,60 a | 0,0316 | 0,676 |
| Lengthwise diameter, mm | 31,64 a | 31,78 a | 31,79 a | 31,62 a | 0,0892 | 0,899 |
| Transverse diameter, mm | 25,22 b | 25,29 b | 26,10 a | 25,02 b | 0,0460 | 0,001 |
| Shell thickness, mm | 0,20 a | 0,20 a | 0,19 a | 0,20 a | 0,0013 | 0,541 |

Same letters do not differ significantly according to Waller Duncan (P <0,05 y P <0,01).
SE: Standard error.
Prob: Probability.

Source: Own elaboration

But in their research, Moura *et al.* (2000), reached an average weight of 10.33 g lower than those reached in the present research, pointing out that lysine levels are not sufficient to promote maximum egg weight, suggesting that the lysine requirement for egg weight is higher than the level for egg production.

## Shell weight

For this variable no statistical differences were found when using Tukey's test (P>0.05) with the averages of 1.51; 1.48; 1.43, and 1.47 g for T0, T1, T2, and T3 treatments in their respective order with a dispersion for each average of ± 0.0110 g. (Table 3). The results found are superior to those found by Melo *et al*. (2008) who used a supplemented ratio with 0.50% seaweed meal reporting a shell weight of 1.13 g.

## Yolk weight

For yolk weight, no significant differences were found (P>0.05), being the averages for T2, T0, T1, T3 of 3.62; 3.58; 3.54 and 3.53 g in their respective order and with a dispersion for each average of ± 0.0268 g. (Table 3).

The results found are superior to those found by Melo *et al*. (2008) in their research where they mention the quality of quail eggs when using seaweed meal and ammonium dihydrogen phosphate, used as an alternative source of phosphorus with an average of 3.20 g. Similarly, Moura *et al*. (2009) reported an average of 3.19 g in their study where they discuss the effect of different dietary levels of total lysine on the egg quality of Japanese quail.

## Albumen weight

The addition of synthetic amino acids in diets with low protein levels did not show significant differences (P>0.05), with weights of 5.71; 5.70; 5.69; 5.60 ± 0,0316 g for quails belonging to T2, T1, T0, and T3 (Table 3). The results are within the ranges of the lineage, but not of those found by Melo *et al*. (2008) where it reached an average of 6.88 g using 0.25% seaweed meal.

## Economic evaluation

The greatest profitability was obtained with the T2 treatment with 20% protein plus the addition of 0.19% synthetic amino acids, with profit/cost indexes of 1.30 USD, which means that for every dollar spent during the research period on the production of laying quail, a net benefit of 0.30 USD was obtained. Table 4.

**Table 4**
*Economic evaluation in the production of quails treated with synthetic amino acids with low levels of crude protein in the diet*

| CONCEPT | TREATMENTS | | | |
|---|---|---|---|---|
| | T0 | T1 | T2 | T3 |
| **OUTFLOW** | | | | |
| Cost of Quails 1 | 212,50 | 212,50 | 212,50 | 212,50 |
| Concentrated 2 | 212,12 | 187,34 | 189,31 | 185,73 |
| Health 3 | 6,58 | 6,58 | 6,58 | 6,58 |
| Prevention 4 | 2,11 | 2,11 | 2,11 | 2,11 |
| Biosecurity 5 | 8,38 | 8,38 | 8,38 | 8,38 |
| Construction and facilities 6 | 14,67 | 14,67 | 14,67 | 14,67 |
| Basic utilities 7 | 5,00 | 5,00 | 5,00 | 5,00 |
| Labor 8 | 55,78 | 55,78 | 55,78 | 55,78 |
| Packaging of the final product 9 | 3,02 | 2,92 | 3,19 | 3,04 |
| **TOTAL OUTFLOW** | 520,15 | 495,27 | 497,50 | 493,79 |
| **INCOME** | | | | |
| Egg sales 10 | 502,55 | 485,95 | 530,95 | 507,05 |
| Quail manure 11 | 16,00 | 16,00 | 16,00 | 16,00 |
| Birds in production 12 | 97,60 | 98,40 | 99,20 | 97,60 |
| **TOTAL INCOME** | 616,15 | 600,35 | 646,15 | 620,65 |
| **PROFIT/COST (USD)** | 1,18 | 1,21 | 1,30 | 1,26 |

1. Cost of Quails $ 1.70/codorniz.
2. 22%PB $ 0,64/kg; 21%PB $ 0,62/Kg; 20%PB $ 0,61/kg; 19%PB $ 0,60/Kg.
3. Cost of antibiotics $ 3.08/Treatment and Vitamins $ 3.50/Treatment
4. Cost of Vaccine $0.01/dose and Iodine $ 0.63/ml
5. Cost Disinfectants $ 8.38.
6. Depreciation of facilities and equipment $ 14.66.
7. Cost of electricity and water $20.
8. Cost of labor $1.89/day
9. Box cost $ 0.15/unit.
(10). Egg sales $ 0.05/unidad.
11. Manure sale $ 2/bag.
12. Quote of birds in production $0.80/bird.

Source: Own elaboration

## CONCLUSIONS

The breeding of quails reports many favorable benefits, due to the low initial investment, easy adaptation to the environment, in addition to obtaining high production of eggs which allow the poultry farmers to develop a highly profitable business with a rapid return on investment.

The increase in demand in the Ecuadorian market for the consumption of quail eggs has allowed poultry farmers to expand their farms with the production of this species, innovating their facilities, carrying out research, and testing new diets that allow them to reach high production levels.

To elaborate diets for quails considering 20% of gross protein plus 0.19% of synthetic amino acids, since according to the results obtained, it is expected to obtain better productive and economic parameters through the use of this level.

Given the consumption of amino acids as free metabolites supplied in the diet, it is necessary to continue studies of metabolic valuation of amino acids in the final product for this animal species.

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