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Bovine meat and Bone Meal as an Economically Viable Alternative in Quail Feeding in the Final Phase

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ABSTRACT

Bovine meat and bone meal (MBM) has been used as a low-cost protein source in corn- and soybean meal-based poultry diets. However, to date, no studies investigating the effect of the dietary inclusion of MBM on the performance of Japanese quails and on egg production costs were found in literature. In this study, 600 Japanese quails in lay were distributed in a completely randomized experimental design consisting of six treatments (replacement levels of soybean meal by MBM:0, 1, 2, 3, 4, and 5%) with five replicates of 20 birds each to investigate if MBM is a viable alternative to maintain or to improve the live and economic performances of these birds. Treatments consisted of a control diet, based on corn and soybean meal, with no inclusion of MBM, and diets formulated with increasing levels (1, 2, 3, 4, and 5%) of MBM inclusion at the expense of soybean meal. The studied parameters were evaluated in four periods of 28 days each. Live performance parameters (egg weight, g; average egg production, %; egg weight, g; feed intake, g; feed conversion ratio per egg mass, kg/kg and per dozen eggs, dz/kg; and livability, %); egg quality parameters (proportion of egg components, yolk, albumen, eggshell %; egg specific weight, g/cm^3); and economic parameter (bio-economic nutritional index) were determined. Only egg weight, egg specific weight, and eggshell percentage were affected ($p<0.05$) by the treatments.

Our results show that inclusion of bovine meat and bone meal can be added to the diet of Japanese quails in lay, causing no performance losses and promoting feed cost savings up to 5.24%.

INTRODUCTION

The commercial production of Japanese quail eggs has greatly developed as an alternative to chicken eggs, as that species presents rapid growth rate, early maturity, high egg production, and low feed intake, and the wide acceptance of their products by consumers created a niche market (Murakami and Ariki, 1998).

Nutrition is the main factor influencing poultry production, and therefore, nutritional management needs to ensure good bird performance and high product quality (Costa, Romanelli & Trabuco, 2010). In addition, feed accounts for approximately 70% of the total production costs, making the research on alternative feedstuffs that reduce feed costs, while ensuring good final product quality essential (Embrapa, 2007).

Meat and bone meal is used as an alternative protein source in the diet of broilers and laying chickens; however, its inclusion depends on the knowledge of their quality, price, and effect on animal performance, including feed intake, feed conversion ratio, weight gain, etc. (Faria Filho *et al.*, 2002). In addition of reducing production costs, the dietary inclusion of MBM allows the utilization of rendered products, which otherwise need to be disposed and may cause environmental pollution (Nascimento *et al*., 2005, Nunes *et al*., 2005, Generoso *et al*., 2008; Araújo *et al*., 2011). Other advantages of the dietary inclusion of bovine MBM, in addition to its nutritional content, are the improvement of feed odor, flavor, and texture, increasing feed palatability, as well as their safety, as it does not contain allergens or antinutritional factors, allowing its use for a wide range of livestock diets (Pereira-Da-Silva and Pezzato, 2000). This suggests that the partial replacement of soybean meal by bovine MBM in laying Japanese quail diets may be an alternative to ensure proper nutrition at a lower cost. Similar to broilers and laying chickens, Japanese quails are able to utilize corn and soybean meal energy. However, because their nutritional requirements are different (Silva *et al*., 2002), research on the replacement of those feedstuffs in Japanese quail diets is required.

The objective of the present study was to evaluate the feasibility of including bovine meat and bone meal in partial replacement of soybean meal (SBM) as an alternative to maintain or to improve the live and economic performances of laying Japanese quails.

MATERIALS AND METHODS

The experiment was carried out at the facilities of the Research and Development Unit of Brotas, Dept. of Development Decentralization, Agribusiness Technology Agency of the state of São Paulo (APTA), Brotas, São Paulo, Brazil.

In this study, 600 42-d-old Japanese quails were housed in a conventional egg-production masonry house (3.0 x 12.0 m) and distributed in cages (100 x 34 x 16 cm) with four internal divisions of 25-cm each, at a density of 20 birds per cage. Each cage was equipped with two nipple drinkers and trough feeders. Feed and water were supplied *ad libitum*. A daily lighting program of 16 hours of light (natural + artificial), from 5h00 to 21h00 was adopted. Birds were vaccinated against Newcastle disease and infectious bronchitis via spray every 60 days.

A completely randomized experimental design was adopted, consisting of six treatments (soybean meal replacement levels by bovine meat and bone meal: 0, 1, 2, 3, 4, or 5%) with five replicates of 20 birds per experimental unit.

The evaluated MBM was chemically analyzed, and contained 93.75% dry matter (DM), 45.75% crude protein (CP), 8.43% ether extract (EE), and 48.17% ash content (A).

The experimental diets were based on corn and soybean meal, and formulated according to the recommendations of Silva *et al*. (2007) and the chemical composition of the feedstuffs included in the formulation were obtained from the Brazilian Tables of Rostagno *et al*. (2005). Digestible amino acid levels were calculated based on the coefficients of digestibility of individual amino acids determined for a typical diet for Japanese quails in lay fed diets containing 20-23% crude protein and including 52% of corn and up to 38% of soybean meal (Ribeiro *et al*., 2003; Rostagno *et al*., 2005 cited by Silva *et al*., 2007).

The ingredients and the calculated nutritional composition of the experimental diets is shown in Table 1.

The duration of the experiment was 112 days, divided four 28-d cycles. Feed intake was calculated as feed supply minus feed residues in each experimental period, corrected for mortality. Egg production was determined as the number of eggs laid per day (n. of eggs/d) and egg production percentage (%), dividing the number of eggs laid by the number of birds per experimental unit and multiplying the result by 100. Eggs were individually weight to determine egg weight (g). Egg mass (g/bird/d) was calculated as the ratio between total egg production and average egg weight. Feed conversion ratio was calculated as the ratio between feed intake and egg mass (kg feed/kg egg mass) and between feed intake and dozen eggs produced (kg feed/dz eggs). Mortality was recorded and livability was determined as the percentage of live birds (%).

Eggs were collected during the last three days of each 28-d cycle for egg quality assessment. The parameters evaluated were egg component weight (yolk, albumen, and eggshell) relative to total egg weight and expressed as a percentage, and egg specific gravity (g/cm^3).Eggs were individually weighed using a digital scale (0.001-g precision). Egg specific gravity was determined immersing the eggs in graded saline solutions (1.065 to 1.100 g.cm^{-3}, at 0.005g.cm^{-3} intervals), according to Moreng & Avens (1990). Eggs were then broken, their components (yolk, albumen, and eggshell) were individually weighed, and their weight relative to total egg weight was calculated and expressed as a percentage.

Table 1 – Ingredients and calculated nutritional levels of the experimental diets fed to Japanese quails in lay.

	Experimental diets					
Ingredients (%)	T1	T2	T3	T4	T5	T6
Ground corn	52.58	53.14	53.73	54.27	54.87	55.47
Soybean meal (45.5% CP)	36.10	35.11	34.12	33.13	32.12	31.11
Bovine meat and bone meal	0.00	1.00	2.00	3.00	4.00	5.00
Soybean oil	1.45	1.30	1.13	0.99	0.82	0.65
Calcitic limestone (38.4% Ca)	6.98	6.90	6.80	6.66	6.55	6.44
Dicalcium phosphate	1.94	1.60	1.27	1.00	0.69	0.38
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Mineral and vitamin supplement[1]	0.60	0.60	0.60	0.60	0.60	0.60
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated nutritional levels						
Metabolizable energy (kcal/kg)	2750	2750	2750	2750	2750	2750
Crude protein (%)	21.0	21.0	21.0	21.0	21.0	21.0
Crude fiber (%)	3.27	3.23	3.19	3.15	3.11	3.07
Calcium (%)	3.2	3.2	3.2	3.2	3.2	3.2
Available phosphorus (%)	0.46	0.46	0.46	0.46	0.46	0.46
Dig. methionine (%)	0.45	0.45	0.45	0.45	0.45	0.45
Dig. Methionine + cystine(%)	0.80	0.79	0.79	0.78	0.78	0.79
Dig. Lysine (%)	1.16	1.15	1.14	1.13	1.12	1.11

[1]Content per kg of feed:pantothenic acid 5,000 mg; choline 43,400 mg; niacin 6,680 mg; Vit. A 1,666,000 IU; Vit. B1 500,000 mg; Vit. B12 1,680 mcg; Vit B2 1,000 mg; Vit. B6 666.700 mg; Vit. D3 208,400 IU; Vit. E 3,360 mg; Vit. K3 500 mg; Cu 1,333.300 mg; Fe 8,333.300 mg; I 200 mg; Mn 11,666.600 mg; Zn. 8,333.300 mg; Se 33,330 mg; growth promoter 1,166.670 mg; antioxidant 16,680 mg, carrier q.s.p. 1,000 g.000.000 g.

The economic analysis considered only feed cost, as all the other production costs of the experimental treatments were identical. The feed cost to produce one kg egg was calculated based on feed intake and cost per kg of feed.

The bio-economic nutritional index (BENI) was used to analyze economic viability of the inclusion of MBM in replacement of SBM in laying Japanese quails. This index was proposed by Guidoni, Godoi, & Bellaver (1994), as mentioned by Roll *et al*. (1999), and was calculated for a box with 20 cartons of 30 eggs each, and took into consideration both feed cost and live performance, as shown in the equation:

BENI = n. of boxes with 20 cartons of 30 eggs each – [(feed cost/price of one box with 20 cartons of 30 eggs each) x feed intake].

The prices of the feedstuffs included in the experimental diets and the price of a box with 20 cartons of 30 eggs (USD 84.10) were obtained in September, 2014, from the websites www.ovooline.com.br and www.iea.sp.gov.br of the Instituto de Economia Agrícola (IEA) for the state of São Paulo.

The data of the evaluated parameters were submitted to analysis of variance, and means were compared by the test of Tukey at 5% probability level, using Sisvar statistical software (Ferreira, 2011).

Table 2 – Effect of the dietary replacement of soybean meal by meat and bone meal (MBM) on live performance parameters of laying Japanese quails.

Treatments	Egg weight (g)	Average egg production (%/hen/d)	Egg mass (g)	Feed intake (g/hen/d)	FCR/dz[1] (kg/dz)	FCR/kg[2] (kg/kg)	Livability (%)
0% MBM	12.32a	0.97	9.82	28.86	0.356	2.938	0.998
1% MBM	12.21ab	0.96	9.76	28.59	0.356	2.930	0.996
2% MBM	12.19ab	0.96	9.72	28.56	0.358	2.938	0.996
3% MBM	11.99ab	0.96	9.71	28.42	0.356	2.930	0.996
4% MBM	11.94ab	0.96	9.69	27.98	0.352	2.904	0.100
5% MBM	11.78b	0.96	9.61	27.88	0.350	2.888	0.996
P-value	0.021	0.262	0.299	0.202	0.700	0.895	0.700
Effect	L*	ns	ns	ns	ns	ns	ns
CV (%)	2.04	1.06	1.44	2.35	2.52	2.80	0.48

[1] feed conversion ratio per dozen eggs; [2] feed conversion ratio per egg mass Means in the same column followed by different letters are different by the test of Tukey ($p<0.01$).

L = linear effect; ns = not significant

*($p<0.05$); **($p<0.01$)

RESULTS AND DISCUSSION

The minimum and maximum temperatures (15.42 and 25.04 °C) recorded inside the experimental house are within thermalneutral zone for Japanese quails, and therefore, did not influence the performance results.

Live performance and egg quality parameters are shown in Tables 2 and 3, respectively. There were adverse effects of the dietary inclusion of the animal protein source (p>0.05)on performance and egg quality parameters. However, egg weight decreased and eggshell percentage and egg specific gravity increased with the inclusion of MBM (Table 2).

Egg weight (Yˆ = 12.30 – 0.094 X; r^2 = 0.78) was negatively affected by the replacement of soybean meal by MBM in the diet. The heaviest eggs were obtained with the corn-soybean meal diet that did not contain MBM. This result may be attributed to the higher inclusion of soybean oil in this treatment (Table 1), in agreement with previous reports on the positive effects of dietary linoleic-rich fats on egg weight (Keshavarz & Nakajima, 1995, Grobas *et al*., 1999a, b). The lowest egg weight was observed with the dietary inclusion of 5% MBM, which eggs were 0.54g lighter than those of the control treatment. Our results differ from those of Almeida Paz *et al*. (2010), who obtained heavier eggs from brown layers fed MBM compared with those fed a control diet free from MBM, irrespective MBM inclusion level. This may be attributed to the fact that the control diet used by those authors did not contain oil.

The experimental treatments significantly influenced egg quality parameters presented in Table 3, particularly egg weight, egg specific gravity, and eggshell percentage (Figures 1, 2, and 3, respectively), as well as feed cost and bio-economic nutritional index (BENI; Yˆ = 1.1107 + 0.00343 X; r2 = 0.97). The dietary inclusion of MBM did not affect yolk and albumen percentages.

Egg weight linearly decreased as the dietary inclusion level of MBM, whereas eggshell percentage and egg specific gravity (g/cm³), indicating that the dietary inclusion of MBM improved eggshell characteristics (Table 3; Figures 2 and 3).

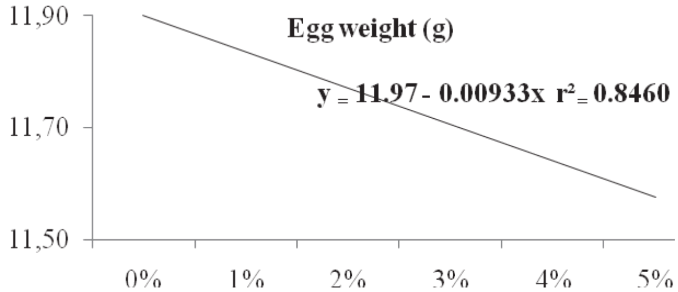

Figure 1 – Egg weight of laying Japanese quails fed different MBM levels in replacement of soybean meal.

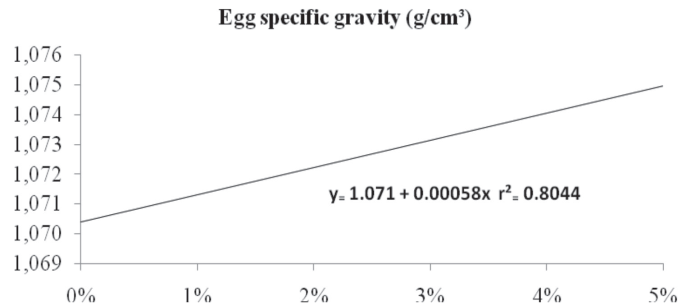

Figure 2 – Egg specific gravity of laying Japanese quails fed different MBM levels in replacement of soybean meal.

Table 3 – Egg quality, feed cost, and bio-economic nutritional index of laying Japanese quails fed different MBM levels.

Treatments	Egg weight (g)	ESG (g/cm³)	Yolk (%)	Albumen (%)	Eggshell (%)	Feed cost USD/kg	Feed cost INBE
0% MBM	11.98ª	1.070b	30.22	61.49	8.00b	0.267	1.111c
1% MBM	11.82ab	1.072ab	30.53	61.56	8.30ab	0.265	1.114bc
2% MBM	11.76ab	1.073ab	30.11	61.65	8.33ª	0.262	1.116bc
3% MBM	11.75ab	1.073ab	30.71	60.84	8.38ª	0.259	1.119abc
4% MBM	11.70ab	1.073ab	30.12	61.55	8.38ª	0.256	1.125ab
5% MBM	11.51b	1.075ª	30.35	61.31	8.44ª	0.253	1.129a
P-value	0.014	0.006	0.530	0.347	0.002		0.0005
Effect	L*	L**	ns	ns	L**		L**
CV (%)	2.99	0.25	3.01	1.54	3.05		

Means in the same column followed by different letters are different by the test of Tukey (p<0.01).

L = linear effect; ns = not significant

*(p<0.05); **(p<0.01)

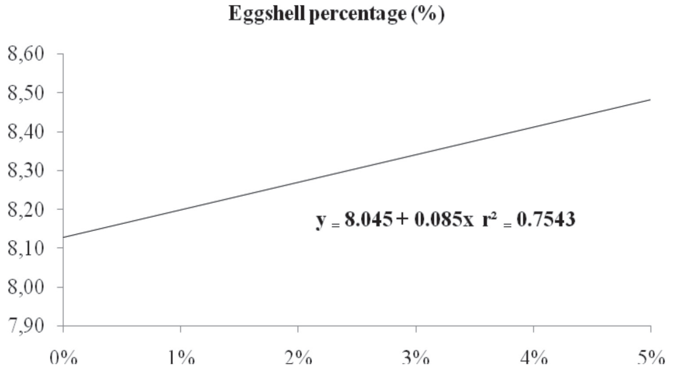

Figure 3 – Eggshell percentage in the eggs of laying Japanese quails fed different MBM levels in replacement of soybean meal.

The eggshell percentage and egg specific gravity results obtained in the present study are consistent with the findings of Almeida Paz *et al*. (2010) with brown layers fed MBM.

The high linoleic acid level present in soybean oil in addition of increasing egg size, hinders dietary calcium absorption, which may explain the worse eggshell percentage and egg specific gravity results obtained with the control diet in the present study (Keshavarz & Nakajima, 1995; Brugalli *et al*., 1999).On the other hand, the organic form of phosphorus in the MBM may have been more efficiently used for eggshell calcification than the inorganic phosphorus derived from dicalcium phosphate, and thereby improved eggshell quality of the eggs laid by the birds fed MBM.

The replacement of SBM by increasing MBM levels improved the bio-economic nutritional index (BENI), as shown in Table 3.Therefore, the addition to 5% of bovine MBM to the diet of Japanese quails in lay did not cause any performance or economic losses,and resulted in an average reduction of up to 5.24% in feed cost.

CONCLUSIONS

Bovine meat and bone meal can partially replace soybean meal in the diet of Japanese quails in lay, causing no performance losses and promoting feed cost savings up to 5.24%.

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