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Digestible lysine levels for brown layers

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ABSTRACT. This study was carried out to evaluate the effects of different digestible dietary lysine levels on performance and egg quality characteristics, from 25 to 41 weeks of age. One hundred twenty Hy-Line Brown layers were randomly distributed in five treatments with six replications of four birds each, totaling 30 experimental units. Experimental diets were based on corn and soybean meal, were isocaloric and isonutrient, with differences only in lysine levels (0.70, 0.75, 0.80, 0.85, and 0.90%). The study evaluated feed intake, lysine intake, energy consumption, egg production, egg weight, egg mass, and feed conversion. Internal egg quality was evaluated by Haugh unit, the percentages of yolk and albumen percentage, while external quality was measured by specific gravity, eggshell thickness and shell percentage. It was concluded that the level of 0.70% of digestible lysine or the intake of 708 mg bird^{-1} day^{-1} for Hy-Line Brown layers from 25 to 41 weeks of age can be enough to express the genetic potential.

Keywords: digestible amino acids, egg quality, performance.

Lisina digestível em poedeiras semipesadas

RESUMO. Este estudo foi realizado para avaliar os efeitos de níveis de lisina digestível na dieta sobre as principais características de desempenho e qualidade dos ovos de no período da 25 a 41ª semanas de idade. Foram utilizadas 120 aves Hy-Line Brown, distribuídas em delineamento inteiramente casualizado com cinco tratamentos e seis repetições de quatro aves cada, totalizando 30 parcelas experimentais. As dietas foram formuladas à base de milho e soja, isonutrientes e isocalóricas para todos os tratamentos, com variação apenas nos níveis de lisina digestível (0,70; 0,75; 0,80; 0,85 e 0,90%). Foram avaliados o consumo de ração, o consumo de lisina, o consumo de energia, a produção de ovos, o peso dos ovos, a massa de ovos e a conversão alimentar. A qualidade interna dos ovos foi avaliada através da unidade Haugh, porcentagem dos componentes gema e albúmen e a qualidade externa através da densidade aparente do ovo, espessura e porcentagem de casca. Conclui-se que os níveis de 0,70% de lisina digestível na dieta ou quando o consumo médio diário de lisina digestível é de 708 mg ave^{-1} dia^{-1}, no período de 25 a 41 semanas de idade para poedeiras Hy-Line Brown, é suficiente para que expressem todo o seu potencial genético.

Palavras-chave: aminoácidos digestíveis, qualidade dos ovos, desempenho.

Introduction

Brazil's poultry industry has reached significant notoriety worldwide in recent years. The excellent numbers this sector has obtained within the country's farming industry have only been possible due to improved genetics combined with proper management and bird nutrition, which includes adequate levels of amino acids, protein, energy, vitamins and minerals.

For a long time, layer diets were formulated based on the concept of crude protein, resulting in amino acids rates above animal needs. With the onset of synthetic amino acids, diets with more precise levels of amino acids were adopted, reducing costs, protein levels, and consequently decreasing nitrogen excretion (WAIBEL et al., 2000).

One important aspect within this context is the creation of more precise feeding programs that allow modifications to the nutritional requirements for the different poultry lineages available in the Brazilian market. It then becomes necessary to develop studies that can constantly monitor nutritional requirements and establish more precise feeding programs that can guarantee the full expression of the genetic potential of poultry flocks.

It is known that the intake rates of protein and amino acids in the diet directly influence yolk and albumen composition in eggs (PROCHASKA et al., 1996), and that lysine and methionine have great influence on egg yield and quality. According to Rostagno et al. (2011), brown-egg layers weighing 1600 g need 820 mg of digestible lysine bird^{-1} day^{-1}. Cupertino et al. (2009) recommended daily intake of digestible lysine of 748 mg bird^{-1} day^{-1} for brown-egg layers between 54 and 70 weeks of age, for egg mass.

The objective of this experiment was to evaluate the effects of dietary levels of digestible lysine on the main characteristics of performance, internal and external egg quality for Hy-Line Brown laying hens.

Material and methods

A total of 120 commercial Hy-Line Brown laying hens were used, from 25 to 41 weeks of age.

The birds were allotted in an entirely randomized design, with five treatments (0.70, 0.75, 0.80, 0.85, and 0.90% of digestible lysine in the diet) and six replications of four birds each, totaling 30 experimental plots. The birds were housed individually in galvanized wire cages measuring 0.25 x 0.45 x 0.40 m (width, depth and height, respectively), arranged in a row and featuring trough feeders and nipple drinkers. Feed and water were provided *ad libitum* and the light schedule was 16 hours day^{-1}.

The diets were formulated based on maize and soybean meal for all treatments (Table 1), with variation only in lysine levels.

Egg yield was recorded daily, and all eggs were collected every 15 days from each plot to determine egg weight and mass. Leftover feed were also weighed every 15 days to determine intake, feed conversion, energy expenditure and lysine intake. Yolk percentage; albumen percentage, weight and height; and Haugh unit (HAUGH, 1937) were measured to assess internal egg characteristics. For external egg quality characteristics, shell weight, shell percentage and specific gravity of eggs were measured. According to Card and Nesheim (1968), the equation used to calculate the Haugh unit is:

$$HU = 100\log (H + 7.57 - 1.7^{W0.37}),$$

which:

H = albumen height;

W = whole egg weight.

The effect of dietary lysine level on characteristics of performance, internal and external egg quality was evaluated by multiple regression analysis, using SAS® 9.1 software (SAS, 2004).

Results and discussion

None of the studied characteristics was influenced by dietary lysine levels, showing that the 0.70% rate of digestible lysine, which

Table 1. Percent and calculated composition of experimental diets.

Ingredient	Digestible lysine levels (%)				
	0.70	0.75	0.80	0.85	0.90
Grain Maize	63.80	63.78	63.78	63.88	63.94
Soybean meal	15.83	15.46	15.09	14.72	14.65
Gluten Meal 60%	7.15	7.29	7.44	7.58	7.72
Soybean Meal	0.09	0.09	0.09	0.08	0.08
Lime	9.42	9.42	9.42	9.42	9.42
Dicalcium Phosphate	1.66	1.66	1.66	1.67	1.67
Salt	0.42	0.43	0.44	0.43	0.43
Methionine*	0.54	0.65	0.65	0.65	0.65
L-Lysine HCl	0.14	0.21	0.28	0.36	0.44
Choline Chloride	0.05	0.05	0.05	0.05	0.05
Vit. Min. Supplement**	0.10	0.10	0.10	0.10	0.10
Inert	0.80	0.86	1.00	1.06	0.94
Total	100	100	100	100	100
Calculated composition (%)					
ME (kcal kg^{-1})	2,800	2,800	2,800	2,800	2,800
Crude protein	18.00	18.00	18.00	18.00	18.00
Calcium	4.10	4.10	4.10	4.10	4.10
Available P	0.40	0.40	0.40	0.40	0.40
Sodium	0.20	0.20	0.20	0.20	0.20
Linoleic Acid	1.50	1.50	1.50	1.50	1.50
Digestible methionine	0.35	0.35	0.35	0.35	0.35
Digestible met + cys.	0.63	0.63	0.63	0.63	0.63
Digestible threonine	0.56	0.56	0.56	0.55	0.55
Digestible tryptophan	0.15	0.14	0.14	0.14	0.14

*HMTBA – 2-hydroxy-4-(methylthio)butanoate. **Supplementation with vitamins, minerals and additives per kg of feed: Vit. A: 9100 IU; Vit. D_3: 1820 IU; Vit. E: 6 mg; Vit. K: 0.5 mg; Vit. B_2: 2.56 mg; Vit B_{12}: 5.48 mg; Calcium Pantothenate: 1.96 mg; Niacin: 5 mg; Choline: 12.4 mg; Selenium: 0.148 mg; Copper: 0.2 mg; Iron: 50 mg; Zinc: 73.6 mg; Manganese: 61.8 mg; Iodine: 0.43 mg; Methionine: 450 mg; Antioxidant: 1 mg.

corresponds to 708 mg of lysine bird^{-1} day^{-1} is sufficient to assure high yields (Table 2).

In a study with lightweight laying hens from 42 to 64 weeks of age, Prochaska et al. (1996) reported no increase in feed intake, for increments in lysine from 677 to 1,154 mg bird^{-1} day^{-1}. However, in the same study the authors reported a significant increase in albumen and yolk weight.

The same authors, working with 23-38-weeks-old Hy-line W36 layers and using feeds providing lysine intakes of 638, 828, 1,062, and 1,165 mg bird^{-1} day^{-1}, observed that feed intake was significant reduced for the highest lysine level (1,165 mg bird^{-1} day^{-1}) when compared to the lowest level (638 mg bird^{-1} day^{-1}). Dietary lysine levels did not affect egg weight, which was confirmed in the present experiment.

Cupertino et al. (2009), working with lightweight and brown-egg layers, found a linear effect for feed intake in lightweight hens, which was not observed in brown-egg layers, in agreement with our study, demonstrating a lower response to lysine level on intake for this lineage. The same authors also found a linear effect for lysine intake as levels increased in the diet, but found differences in internal egg quality traits as lysine levels, unlike our study.

The results for egg quality characteristics are indicated in Table 3. There were no significant differences among treatments on egg quality.

Scheideler et al. (1996) obtained a positive linear response to the addition of total lysine in the diet of 500 to 1,000 mg bird^{-1} day^{-1}, in 100 mg increments, for the parameters of egg yield of Hisex White layers. Faria et al. (2003), working with Hy-Line W36 birds in two experiments in which the birds were fed diets based on maize and soybean, with growing levels 0.48 to 0.76% and 0.52 to 0.80% de lysine total in gradual increments of 0.04%, concluded that the optimum daily intake of lysine is 633.1 and 606.5 mg bird^{-1} day^{-1} (experiments 1 and 2, respectively) for egg yield. Rocha et al. (2009) defined inclusion as at least 798 mg of digestible lysine bird^{-1} day^{-1} for lightweight layers between 24 and 40 weeks old.

Matos et al. (2009), in an experimental assay using Lohmann LSL layers between 25 and 44 weeks of age, concluded that in order to optimize feed conversion it is necessary to use 0.80% digestible lysine and 0.50% threonine in the diet. The differences observed between the different trials in the levels of amino acids required may be due to bird lineage, bird age, egg yield rate, levels of dietary protein and amino acids, nutrient availability in ingredients or diet composition (ISHIBASHI et al., 1998; LEESON; SUMMERS, 2001).

Santos et al. (2014), working with Isa Brown layers starting at 28 weeks of age, offered low-protein diets (14% CP) and digestible lysine levels from 0.60 to 0.90%. Those authors found smaller

Table 2. Mean values of feed intake (g bird^{-1} day^{-1}), lysine intake (mg bird^{-1} day^{-1}), energy expenditure (kcal bird^{-1} day^{-1}), egg yield (%), egg weight (g), egg mass (g bird^{-1} day^{-1}) and feed conversion (g feed g of egg mass^{-1}) for layers fed various digestible lysine levels.

Digestible lysine (%)	Feed intake (g day^{-1})	Energy expenditure (kcal bird^{-1} day^{-1})	Egg yield (%)	Egg weight (g)	Egg mass (g bird^{-1} day^{-1})	Feed conversion (g feed g egg mass^{-1})
0.70	101.11	283.11	95.75	59.17	56.67	1.79
0.75	102.59	287.25	96.15	59.64	57.34	1.79
0.80	99.13	277.56	93.14	58.09	54.10	1.83
0.85	99.12	277.54	95.10	59.31	56.40	1.76
0.90	82.98	277.85	95.73	57.67	54.54	1.82
P	ns	ns	ns	ns	ns	ns
CV(%)	2.93	2.93	1.77	2.79	4.22	3.21

ns: non-significant.

Table 3. Mean values of yolk percentage, yolk weight (g), albumen percentage, albumen weight (g), albumen height (mm), Haugh unit, shell percentage, shell weight (g) and specific gravity (mg L^{-1} H_2O) for layers fed various digestible lysine levels.

Digestible lysine (%)	Yolk (%)	Yolk weight (g)	Albumen (%)	Albumen weight (g)	Albumen height (mm)	Haugh unit	Shell (%)	Shell weight (g)	Specific gravity (mg L^{-1} H_2O)
0.70	23.30	13.73	67.42	39.87	10.39	101.09	9.41	5.54	1.090
0.75	22.68	13.51	67.91	40.40	10.32	100.76	9.38	5.60	1.090
0.80	22.20	12.94	68.38	40.12	10.61	102.09	9.43	5.49	1.090
0.85	22.64	13.46	67.67	40.40	10.70	102.33	9.69	5.76	1.090
0.90	22.29	13.15	68.32	40.06	10.97	103.52	9.38	5.53	1.090
P	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV(%)	3.81	4.58	1.50	5.46	5.94	2.45	3.64	3.77	0.25

ns: non-significant.

egg size and greater shell percentage in eggs from birds that received lower lysine levels when compared to controls (16.92% CP). The requirement level found by the authors was 0.75% digestible lysine, which corresponds to an intake of 876 mg of lysine bird^{-1} day^{-1}, in diets with that protein rate, without compromising performance and internal or external egg quality.

While studying the digestible lysine nutritional requirement for laying hens between 34 and 50 weeks of age, Sá et al. (2007) found the best responses for brown-egg layers when fed diets formulated with 0.715% digestible lysine. Jordão Filho et al. (2006), working with lysine requirements for brown-egg layers during the peak laying period, recommends the use of 0.92% total lysine or 0.84% digestible lysine for birds during that laying period. The recommended lysine intake values found in the Hy-Line Brown Manual (2002-2004) (HY-LINE, 2004) stand between 910 and 930 mg bird^{-1} day^{-1} of total lysine. Rostagno et al. (2011) recommends approximately 0.68% digestible lysine for birds in that age and weight, which is quite near the value found in our study.

Conclusion

The results of this work indicate that brown-egg layers can express their full productive genetic potential when fed 0.70% digestible lysine in the diet, or when mean daily intake of digestible lysine is 708 mg bird^{-1} day^{-1}.

References

CARD, L. E.; NESHEIM, M. C. **Produccion avicola**. New York: Ithaca, 1968.

CUPERTINO, E. S.; GOMES, P. C.; ALBINO, L. F. T.; DONZELE, J. L.; MELLO, H. H. C.; SCHMIDT, M.; CALDERANO, A. A. Exigência nutricional de lisina digestível para galinhas poedeiras de 54 a 70 semanas de idade. **Revista Brasileira de Zootecnia**, v. 38, n. 3, 480-487, 2009.

FARIA, D. E.; HARMS, R. H.; ANTAR, R. S.; RUSSELL, G. B. Re-evaluation of the lysine requirement of the commercial laying hen in a corn-soybean meal diet. **Journal of Applied Animal Research**, v. 23, n. 1, p. 161-174, 2003.

HAUGH, R. R. The Haugh unit for measuring egg quality. **United States Egg Poultry Magazine**, v. 43, n. 1, p. 552-555, 1937.

HY-LINE. **Guia de manejo da Hy-line variedade Brown**: 2002-2004. Nova Granada: Hy-line do Brasil, 2004.

ISHIBASHI, T.; OGAWA, Y.; ITOH, T.; FUJIMURA, S.; KOIDE, K.; WATANABE, R. Threonine requirements of laying hens. **Poultry Science**, v. 77, n. 7, p. 998-1002, 1998.

JORDÃO FILHO, J.; SILVA, J. H. V.; SILVA, E. L.; RIBEIRO, M. L. G.; COSTA, F. G. P.; RODRIGUES, P. B. Exigência de lisina para poedeiras semipesadas durante o pico de postura. **Revista Brasileira de Zootecnia**, v. 35, n. 4, p. 1728-1734, 2006.

LEESON, S.; SUMMERS, J. D. **Commercial poultry nutrition**. Guelphy: Uniersity Books, 2001.

MATOS, M. S.; LEANDRO, N. S. M.; STRINGHINI, J. H.; CAFÉ, M. B.; CARVALHO, F. B.; GOMES, N. A. Níveis de lisina e treonina digestíveis para poedeiras comerciais Lohmann LSL de 24 a 44 semanas de idade. **Acta Scientiarum. Animal Sciences**, v. 31, n. 1, p. 19-24, 2009.

PROCHASKA, J. F.; CAREY, J. B.; SHAFER, D. J. The effect of L-Lysine intake on egg component yield and composition in laying hens. **Poultry Science**, v. 75, n. 10, p. 1268-1277, 1996.

ROCHA, T. C.; GOMEZ, P. C.; DONZELE, J. L. ; BARRETO, S. L. T.; MELLO, H. H. C.; BRUMANO, G. Níveis de lisina digestível em rações para poedeiras no período de 24 a 40 semanas de idade. **Revista Brasileira de Zootecnia**, v. 38, n. 9, p. 1726-1731, 2009.

ROSTAGNO, H. S.; ALBINO, L. F. T.; DONZELE, J. L.; GOMES, P. C.; OLIVEIRA, R. F.; LOPES, D. C.; FERREIRA, A. S.; BARRETO, S. L. T.; EUCLIDES, R. F. **Tabelas brasileiras para aves e suínos**. Viçosa: UFV, 2011.

SÁ, L. M.; GOMES, P. C.; ROSTAGNO, H. S.; ALBINO, L. F. T.; D'AGOSTINE, P. Exigência nutricional de lisina digestível para galinhas poedeiras no período de 34 a 50 semanas de idade. **Revista Brasileira de Zootecnia**, v. 36, n. 6, p. 1829-1836, 2007.

SANTOS, T. A.; GERALDO, A.; MACHADO, L. C.; PELÍCIA, K.; SIMÃO, S. D.; FILHO, J. A. V. Digestible lysine levels for laying hens and their effects on egg quality. **Acta Scientiarum. Animal Sciences**, v. 36, n. 1, p. 41-47, 2014.

SAS-Statistical Analisys System. **User's guide**. Version 9.1. Cary: SAS Institute Inc., 2004.

SCHEIDELER, S. E.; NOVAK, C.; SELL, J. L.; DOUGLAS, J. Hisex white leghorn lysine requirement for optimum body weight and egg production during early lay. **Poultry Science**, v. 75, n. 1, p. 86, 1996.

WAIBEL, P. E.; CARLSON, C. W.; BRANNON, J. A.; NOLL, S. L. Limiting amino acids after methionine and lysine with growing turkeys fed low-protein diets. **Poultry Science**, v. 79, n. 9, p. 1290-1298, 2000.

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