Crude protein levels in diets for laying hens

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Additional keywords

Crude protein.
Egg quality.
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SUMMARY

The aim of this study was to evaluate dietary crude protein (CP) levels for laying hens. 180 Hy-Line W-36 laying hens, with ages ranging from 27 to 43 weeks old, were distributed according to a randomized block design into three treatments with 10 replicates of six birds per cage. The dietary nutritional levels were adequate, except for CP. The treatments were 152, 172, and 182 g/kg. The following parameters were evaluated: feed intake (FI, g/day), egg production (EP, g/kg), egg weight (EW, g), egg mass (EM, g/day), feed conversion ratio (FCR, kg/kg and kg/dozen), yolk (g/kg of EW), eggshell (g/kg of EW), and albumen (g/kg of EW). Feed intake was not influenced by dietary CP levels ($p>0.05$). Egg weight, EM, FCR (kg/kg), and albumen were not influenced ($p>0.05$) by the treatments. Birds fed on diets with 172 g/kg CP showed an improvement ($p<0.05$) in EP of 2.35% compared with the level of 152 g/kg CP. Increasing dietary CP levels showed better ($p<0.05$) FCR (kg/dozen) compared to the lowest CP level. Yolk and eggshell weight were influenced ($p<0.05$) by increasing dietary CP levels. The dietary CP levels of 172 and 182 g/kg increased yolk weight by 6.33% and 10.1% compared to the lowest CP level respectively. The eggshell weight showed an average improvement of 6.31%, increasing the dietary CP levels. The CP level of 172 g/kg is recommended in diets for white-eggs laying hens from 27 to 43 weeks of age.

Niveles de proteína bruta en dietas para gallinas ponedoras

Palabras clave adicionales

Proteína bruta.
Calidad del huevo.
Gallinas
Rendimiento.

RESUMEN

El objetivo de este trabajo fue evaluar niveles de proteína bruta (PB) en gallinas ponedoras Hy-Line W-36 de 27 a 43 semanas de edad. 180 aves fueron distribuidas en un diseño en bloques con tres tratamientos, 10 repeticiones y seis animales por cada uno. Los niveles nutricionales fueron los adecuados excepto para la PB. Los niveles evaluados fueron 152, 172 y 182 g/kg PB. Fue estimado el consumo de pienso (CP, g/día), producción de huevos (PDH, g/kg), peso de huevo (PH, g), masa de huevo (MH, g/día), conversión alimenticia (CA, kg/kg y kg/docena), peso de yema (g/kg de PH), de cáscara (g/kg de PH) y de albumen (g/kg de PH). El consumo no fue influenciado por los niveles de PB de las dietas ($p>0,05$). El PH, MH, CA y Peso de albumen, no fueron afectados ($p>0,05$) por el nivel de PB de los piensos. Las aves alimentadas con dietas con 172 g/kg PB mostraron mejoras ($p>0,05$) en el PDH en un 2.35% en comparación al nivel de 152 g/kg PC. El aumento de PB mejoró ($p<0,05$) la CA (kg/docena), el peso de la yema y de la cascara en comparación al nivel menor de PB. Los niveles de PB de 172 y 182 g/kg aumentaron el peso de la yema en un 6,33 y un 10,1% en comparación al nivel más bajo de PB, respectivamente. Igualmente el peso de la cáscara aumentó un 6.31% al aumentar el nivel de Pb de las dietas. El nivel de 172 g/kg de PB es el recomendado para gallinas ponedoras de huevo blanco de 27 a 43 semanas de edad.

Información

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INTRODUCTION

Dietary crude protein (CP) levels can be reduced if crystalline amino acids are added to the feed. This allows the application of the ideal protein concept in feed formulation, enhancing amino acid utilization and reducing nitrogen excretion (Keshavarz and Austic, 2004). Currently, this higher utilization in feed formulation is accomplished due to the market availability of crystalline amino acids at affordable prices (Andrade, 2004).

Preliminary studies have shown the possibility to reduce dietary protein levels when crystalline AA are added to feed (Tavernari *et al.*, 2013; Lelis *et al.*, 2014) but this practice for laying hens is influenced by the bird's feed intake, being necessary adjust the crude protein level according to the hen feed intake.

Thus, the objective of the present study was to evaluate the effect of crude protein levels in diets for laying hens.

MATERIALS AND METHODS

The trial was performed at the Poultry Farm of the Department of Animal Science of the Universidade Federal de Viçosa. A total of 180 Hy-Line W-36 laying hens from 27- to 43-wk-old, were evaluated for an experimental period of 16 weeks. The study comprised 4 evaluation periods of 28 days each. The study began on day 0.

Birds were distributed according to a randomized block design into three treatments with 10 replicates of six birds per cage (60 birds for each treatment). Experimental blocks were determined according to egg production, totaling 10 blocks.

The following treatments were evaluated: T1 – 152 g/kg CP, T2 – 172 g/kg CP, and T3 – 182 g/kg CP.

Diets were formulated to supply nutritional requirements for hens, except for crude protein, according to the Brazilian tables for poultry and swine (Rostagno *et al.*, 2011), **table I**.

The house temperatures were daily monitored by minimum-maximum thermometers. The maximum was 28±1.8˚C and minimum was 17±2.7˚C. The following parameters were evaluated: feed intake (FI, g/day), egg production (EP, g/kg), egg weight (EW, g), egg mass (EM, g/day), feed conversion ratio (FCR, kg/kg and kg/dozen), yolk weight (g/kg of EW),

Table I. Ingredients and nutrient composition of experimental diets (g/kg diet as-fed basis) (Ingredientes y composición nutricional de las dietas experimentales (g/ kg de racion).

Ingredients	T1	T2	T3
Corn	654.75	594.75	579.71
Soybean meal 45%	166.87	222.36	214.20
Gluten corn meal 60%	40.00	38.56	65.00
Soybean oil	16.20	27.02	24.00
Limestone	94.08	93.95	94.00
Dicalcium phosphate	14.14	13.87	13.80
Salt	5.24	5.24	5.24
Potassium carbonate	1.51	-	0.26
L-Lysine HCl 79%	1.63	-	-
DL-Methionine 99%	1.94	1.55	1.08
L-Isoleucine 98.5%	-	-	-
L-Threonine 98%	0.37	-	-
L-Triptophan 98%	0.23	-	-
L-Valine 98.5%	0.33	-	-
Choline chloride 60%	0.60	0.60	0.60
Mineral supplement[1]	0.50	0.50	0.50
Vitamin supplement[2]	1.50	1.50	1.50
BHT	0.10	0.10	0.10
Calculated nutrient composition[3] (g/kg diet as fed basis)			
Crude protein, g/kg	152.0	172.0	182.0
Crude protein, g/kg[4]	148.0	169.0	179.0
MEn (Kcal/kg).	2900	2900	2900
Calcium, g/kg	40.2	40.2	40.2
Available phosphorus, g/kg	3.50	3.50	3.50
Sodium, g/kg	2.55	2.55	2.55
Potassium, g/kg	5.80	5.80	5.80
Digestible lysine, g/kg	7.27	7.27	7.27
Digestible methionine + cystine, g/kg (Digestible methionine + cystine-to-digestible lysine ratio)	6.83 (94)	6.83 (94)	6.83 (94)
Digestibe methionine, g/kg (Digestible methionine-to-digestible lysine ratio)	4.46 (61)	4.28 (59)	4.10 (56)
Digestible threonine, g/kg (Digestible threonine-to-digestible lysine ratio)	5.53 (76)	5.84 (80)	6.19 (85)
Digestible tryptophan, g/kg (Digestible tryptophan-to-digestible lysine ratio)	1.67 (23)	1.71 (24)	1.73 (24)
Digestible valine, g/kg (Digestible valine-to-digestible lysine ratio)	6.91 (95)	7.41 (102)	7.90 (108)
Digestible isoleucine, g/kg (Digestible isoleucine-to-digestible lysine ratio)	5.87 (81)	6.74 (93)	7.18 (99)
Digestible arginine, g/kg (Digestible arginine-to-digestible lysine ratio)	8.45 (116)	9.98 (137)	10.17 (140)

[1]Mineral supplement (supply per kg diet): manganese ($MnSO_4 . H_2O$), 65 mg; iron ($FeSO_4 . H_2O$), 50 mg; zinc (ZnO), 60 mg; copper ($CuSO_4 . 5H_2O$), 10 mg; iodine (KI), 0.8 mg; selenium (Na_2SeO_3), 0.3 mg; [2]Vitamin supplement (supply per kg diet): vitamin A (*trans* – retinyl acetate), 7000 IU; vitamin D3 (cholecalciferol), 1600 IU; vitamin E (all – *rac* – tocoferol acetate), 10 IU; vitamin K (bisulfate menadione complex), 1.7 mg; vitamin B6, 1.4 mg; pantothenic acid (D–calcuim panthenate), 7 mg; biotin, 0.03 mg; nicotinic acid, 20 g; vitamin B12 (cyanocobalamin), 0.010 mg; [3]Composition of the Brazilian Tables for Poultry and Swine basing on ingredients (2011); [4]Analyzed composition.
BHT: Butyl hydroxy toluene, 99%.

eggshell weight (g/kg of EW), and albumen weight (g/kg of EW).

The main effects of the study are the three dietary crude protein levels. The statistical model used was

$$Y_{ijk} = \mu + \tau_i + \beta_j + (\tau\beta)_{ij} + \delta_k + \varepsilon_{ijk}$$

Where Y_{ijk} is the observation *k* of treatment *i* in period *j*; μ is the overall mean; τ_i is the effect of treatment "i"; βj is the effect of period *j*; $(\tau\beta)_{ij}$ is the interaction of treatment *i* × period *j*; δ_k is the effect of block *k*; ε_{ijk} is the residual random error.

All data were analyzed using the GLM procedure of SAS statistical package (SAS Institute, 2004) and means were compared through the test of Tukey at a 5% probability level.

RESULTS AND DISCUSSION

There was no interaction between crude protein levels and experimental periods (p>0.05).

Feed intake was not influenced (p>0,05) by the dietary CP levels **(table II)**. Thus, in the present study the average FI of birds observed was 94.1 g/day. The nutritional requirements of laying hens are based on birds intake (NRC, 1994; Rostagno *et al.*, 2011), being necessary to know the FI to formulate hen diets.

Egg weight, EM, FCR (kg/kg), and albumen were not influenced (p>0,05) by dietary crude protein levels. Preliminary studies have been shown that dietary crude protein levels ranging between 140 and 170 g/kg did not influence the performance of laying hens at their production stage (Costa *et al.*, 2004; Pavan *et al.*, 2005). These results suggest that variations on crude protein levels from 140 to 170 g/kg cannot produce deficiency on the hens. Probably, a higher dietary CP variation than that used in these preliminary studies should be necessary.

In the present study, birds fed on diets with 172 g/kg CP showed an improvement (p<0,05) on EP by 2.35% compared with the lowest CP level (152 g/kg CP). Increasing dietary CP levels showed better (p<0,05) FCR (kg/dozen) compared with the treatment containing 152 g/kg CP. Preliminary studies have reported the level of 175 g/kg CP as the adequate for laying hens in production phase (Costa *et al.*, 2004; Carioca *et al.*, 2010).

When dietary crude protein was reduced until 152 g/kg CP, crystalline AA were added to meet bird requirements but hens fed on a diet with the lowest level of CP showed the worst results compared to those fed on diets containing dietary CP levels over than the nutritional recommendations as preconized by Rostagno *et al.* (2011). These results suggest that more studies are needed to update the nutritional recommendations for these AA. Preliminary studies reported the importance of updating the percentage ratios of amino acids to Lys for laying hens and broilers due to the genetic improvements on birds utilized on poultry production (Tavernari *et al.*, 2013; Campos *et al.*, 2012; Lelis *et al.*, 2014).

The yolk and eggshell weight were influenced (p<0.05) by dietary CP levels. Yolk weight showed an improvement by 6.33 % when comparing CP level of 172g/kg with the lowest level. At the same, the highest CP level led to an improvement by 10.1 % compared with the level of 152 g/kg CP. The eggshell weight showed an improvement by 6.31% with an increase on the dietary CP levels. Several studies have shown that an increase in dietary CP levels may improve egg contents (Costa *et al.*, 2004; Pavan *et al.*, 2005; Novak *et al.*, 2006). Main benefits were reported in yolk (Pavan *et al.*, 2005), yolk protein percentage (Novak *et al.*, 2006), eggshell (Novak *et al.*, 2006), and albumen (Costa *et al.*, 2004; Pavan *et al.*, 2005). In fact, laying hens are capable

Table II. Performance and egg quality of layer hens fed on diets with different crude protein levels from 27- to 43-week-old (Rendimiento y calidad de los huevos de gallinas ponedoras alimentadas con dietas con diferentes niveles de proteina bruta en la fase de 27 a 43 semanas de edad).

Item	Crude protein levels (g/kg)			P-value	CV
	152	172	182		
Feed intake, g/day	94.4	93.9	93.9	ns	3.12
Egg production, g/kg	892^{B}	913^{A}	900^{AB}	0.002	3.34
Egg weight, g	60.9	60.5	60.9	ns	2.94
Egg mass, g/day	54.2	55.3	54.9	ns	3.81
Feed conversion ratio (kg/dozen)	1.280^{B}	1.236^{A}	1.252^{A}	0.001	4.07
Feed conversion ratio (kg/kg)	1.740	1.701	1.713	ns	4.54
Yolk, g/kg of egg weight	158^{C}	168^{B}	174^{A}	0.001	4.39
Eggshell, g/kg of egg weight	53.9^{B}	57.3^{A}	55.8^{AB}	0.005	8.01
Albumen, g/kg of egg weight	387.2	388.2	392.3	ns	4.10

^{A,B,C}Means followed by different capital letters in the same row are different by the Tukey test at 5% probability level; sample size (n) = 120, for performance and egg traits.
ns: not significant.
CV (%) = coefficient of variation.

of transferring nutrients to the eggs and increasing on dietary crude protein levels may influence directly on egg quality.

CONCLUSION

The dietary crude protein level of 172 g/kg is recommended to improve egg production and egg quality of white laying hens from 27 to 43 weeks of age.

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