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Digestible lysine for broilers from different commercial strains in the final phase

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ABSTRACT. This study aimed to evaluate different digestible lysine levels in diets for broilers chickens from different commercial strains, from 49 to 56 days of age, on performance and carcass characteristics. A total of 432 male broilers from 49 days old were used, with an average weight of 3560±250 g. It was used a completely randomized design in a factorial arrangement 3x4, and the birds, from three strains (Cobb 500, Hubbard Flex and Ross 308) were divided into four levels of digestible lysine (0.800, 0.950, 1.100 and 1.250%), with four replicates of 12 birds each. It was evaluated the weight gain, feed intake, feed conversion ratio, carcass yield, breast yield, breast meat yield and the yield of the thigh and drumstick. There was no interaction between lysine levels and commercial strains of broiler chickens. The different lysine levels did not influence ($p \geq 0.05$) performance and carcass yield. There are significant differences between strains for feed intake and carcass characteristics. The Cobb 500 strain had higher breast yield and breast meat ($p < 0.05$), while the Hubbard Flex and Ross 308 strains had higher yield of the thigh and drumstick ($p < 0.05$).

Keywords: amino acids, breast meat, performance, genotypes, carcass yield.

Lisina digestível para frangos de corte de diferentes linhagens na fase final de criação

RESUMO. Objetivou-se avaliar diferentes níveis de lisina digestível em rações para frangos de corte de diferentes linhagens comerciais na fase de 49 a 56 dias de idade sobre o desempenho e características de carcaça. Foram utilizados 432 frangos de corte machos de 49 dias de idade, com peso médio inicial de 3560±250 g. Utilizou-se o delineamento inteiramente casualizado em arranjo fatorial 3x4, sendo que as aves, oriundas de três linhagens (Cobb 500, Hubbard Flex e Ross 308), foram distribuídas em quatro níveis de lisina digestível (0,800; 0,950; 1,100 e 1,250%), com quatro repetições de 12 aves cada. Avaliou-se o ganho de peso, o consumo de ração, a conversão alimentar, o rendimento de carcaça, o rendimento de peito, o rendimento de carne de peito e o rendimento de coxa e sobrecoxa. Não houve interação entre os níveis de lisina digestível e as linhagens comerciais de frangos de corte. Os diferentes níveis de lisina não influenciaram ($p \geq 0,05$) o desempenho e rendimento de carcaça. Existem diferenças significativas entre as linhagens para consumo de ração e características de carcaça. Sendo que a linhagem Cobb 500 teve maior rendimento de peito e carne de peito ($p \leq 0,05$), enquanto as linhagens Hubbard Flex e Ross 308 tiveram maior rendimento de coxa e sobrecoxa ($p \leq 0,05$).

Palavras-chave: aminoácido, carne de peito, desempenho, genótipos, rendimento de carcaça.

Introduction

Modern poultry has as one of its pillars the genetic improvement associated with advances in nutrition, which together, provides strains of broiler chickens with more efficient assimilation of dietary nutrients, in order to maximize the muscle deposition. Although similar in terms of production, each strain has different genetic potential, since as given selection pressure for various interesting characteristics, in accordance with the industry interest (Araújo et al., 2002). Thus, when considering that the strains vary in the growth characteristics and carcass yield, they may also have different nutritional requirements (Vieira & Angel, 2012).

The diet handling is an efficient way to improve the features and performance of broiler carcass. In the production of commercial poultry strains intended for meat cuts, with the main objective of breast meat production, lysine is the principal amino acid to be handled in ration (Almeida et al., 2002; Barbosa, Junqueira, Andreotti, Cancherini, &

Araújo, 2001). Although lysine is not the first limiting amino acid for poultry, it is used as amino acid basis for calculating the optimal protein, as it is used almost exclusively for body protein synthesis and does not participate in metabolic interactions with other amino acids (Amarante Júnior et al., 2005; Meza et al., 2015).

There are differences in the characteristics of productive performance, carcass and cuts yield between different broilers strains when adjusting the amino acid density to be delivered in feed in different stages of poultry creation (Corzo, Dozier, & Kidd, 2008; Kidd, Corzo, Hoehler, Miller, & Dozier, 2005). Moran Júnior and Bilgili (1990) evaluated different commercial strains, and observed that by raising the lysine content of the feed in the final phase, there was a significant increase in breast yield and thighs. Thus, it is important to review and study the nutritional needs of broiler chickens, as the steady advance in genetic improvement results in greater protein accumulation in the carcass, and lysine is the amino acid with the highest concentration in the muscle, especially in breast meat (Trindade Neto et al., 2009). Although several studies address the poultry production in several stages, few researches have been directed to the requirements of broiler production in the last period. After all, in this stage the broiler chicken has increased approximately 20% of its weight and consumes more than 25% of the total feed intake in the period production, with possible loss in feed conversion ratios (Barbosa et al., 2001). When considering the chicken meat production, an especial attention is given to the breast meat, mostly in the year-end festivities, making it an alternative to modified strains which have higher cost of production and acquisition to the final costumer.

Thus, the objective was to evaluate the effect of digestible lysine levels in broiler diets from different commercial strains in the final phase, from 49 to 56 days of age, on the performance parameters and carcass yield and cuts.

Material and methods

All procedures in this study, with the use of animals, were made in accordance with the Bioethics and Biosafety Committee from UFVJM, under the protocol nº 016/2011.

This research was conducted in the Poultry Sector of the Animal Science Department, from the Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), in the Diamantina-MG Campus. It was housed 540 broilers chickens, 180 of each strain, male, and reared from 1 to 48 days old. Of this amount, 432 broilers were used, 144 of each strain, male, between 49-56 days old, with average weight of 3560 ± 250 g. It was used a completely randomized design in a factorial arrangement 3x4, with birds from three different strains (Cobb 500, Hubbard Flex and Ross 308), divided into four levels of digestible lysine (0.800, 0.950, 1.100 and 1.250%) without maintaining the ratio with the other amino acids, and with four replicates of 12 birds each.

In the initial period and growth (1 – 48 days of age), the birds were housed in a masonry house with concrete floor and fiber cement tiles, at 1384 m of altitude. The birds were distributed in 36 boxes with 1.62 x 1.55m each, making 2.5 m^2, with 15 birds per pen at a density of 6 birds/m^2, until they were 48 days old. During this period the birds were feed in accordance with the creation phase, following the recommendations of Rostagno et al. (2011). Each pen was equipped with a tube feeder and a bell drinker. The light program adopted throughout the trial was continuous with partial supply of artificial light. The material used as poultry litter was wood shavings with a thickness of approximately 10 cm. During the trial period (49 – 56 days) it was provided food and water *ad libitum*.

The experimental diets were formulated based on corn and soybean meal, in order to meet the nutritional requirements of poultry according to Rostagno et al. (2011) as shown in Table 1.

The performance variables analyzed were feed intake (g^{-1} $bird^{-1}$), weight gain (g^{-1} $bird^{-1}$) and feed conversion ratio (g g^{-1}). The broilers were weighed individually after 49 and 56 days, for the determination of the initial weight, the weight average final and average weight gain. The diets were weighed before and after delivery to the broilers in the trial period to determine the average feed intake and feed conversion ratio.

At 56 days of age, two broiler chickens from each experimental unit were slaughtered after fasting for eight hours. The broilers had an average weight ± 10% of each plot, and the slaughtering procedure was cervical dislocation with subsequent bleeding. Then, the carcasses were eviscerated for carcass yield evaluation (no head, neck, legs and abdominal fat) and cuts (breast, breast meat and thighs and drumsticks). From the weights were calculated carcass yield (carcass $weight^{-1}$ $body^{-1}$ weight platform⋆100) and cuts (weight of the part/carcass weight⋆100).

Table 1. Composition of experimental diets (49 - 56 days).

Ingredients	Digestible lysine levels (%)			
	0.800	0.950	1.100	1.250
Corn	70.932	70.932	70.932	70.932
Soybean meal	23.570	23.570	23.570	23.570
Soy oil	2.572	2.572	2.572	2.572
Dicalcium phosphate	0.905	0.905	0.905	0.905
Limestone	0.663	0.663	0.663	0.663
Salt	0.385	0.385	0.385	0.385
DL-methionine (99%)	0.193	0.193	0.193	0.193
L-lysine HCl (78%)	0.077	0.092	0.107	0.122
Vitamin Supplement[1]	0.100	0.100	0.100	0.100
Mineral Supplement[2]	0.050	0.050	0.050	0.050
Choline chloride (60%)	0.100	0.100	0.100	0.100
Salinomycin (12%)	0.055	0.055	0.055	0.055
Antioxidant – BHT	0.010	0.010	0.010	0.010
Inert[3]	0.388	0.373	0.358	0.343
Total	100.00	100.00	100.00	100.00
Calculated composition				
Metabolizable Energy (kcal kg^{-1})	3200	3200	3200	3200
Crude Protein (%)	17.00	17.00	17.00	17.00
Calcium (%)	0.576	0.576	0.576	0.576
Non-phytate phosphorus (%)	0.269	0.269	0.269	0.269
Digestible Lysine (%)	0.800	0.950	1.100	1.250
Digestible Met + Cist (%)	0.684	0.684	0.684	0.684
Digestible Threonine (%)	0.609	0.609	0.609	0.609
Digestible Valine (%)	0.732	0.732	0.732	0.732
Digestible tryptophan (%)	0.170	0.170	0.170	0.170
Sodium (%)	0.190	0.190	0.190	0.190

[1]Vitamin Supplement: Security levels for kg of product (Min): Folic Acid 750 mg, Pantothenic Acid 12 g, Biotin 25 mg, Niacin 35 g, Vit. A 8.000.000 UI, Vit. B1 1.500 mg, Vit. B12 12.000 mg, Vit. B2 5.000 mg, Vit. B6 2.800 mg, Vit. D3 2.000.000UI, Vit. E15.000 UI, Vit. K3 1.800 mg.[2]Mineral Supplement: Security levels for kg of product (Min): Copper 20 g, Iron 96 g, Iodine 1.400 mg, Manganese 156 g, Selenium 360 mg, Zinc 110 g.[3]Inert: caulim.

The data were statistically analyzed using the SAS (2004) program. As for the lysine levels it was used polynomial regression, and the average of the strains were compared by Tukey test at 5% significance level.

Results and discussion

There was no interaction between lysine levels and the different strains under study for the characteristics of production performance ($p > 0.05$) (Table 2).

Regarding commercial strains, it was observed that the Cobb 500 had lower feed intake ($p < 0.05$) compared to strains Hubbard Flex and Ross 308, presenting no difference ($p > 0.05$) in weight gain and feed conversion ratio. Moreira et al. (2003) evaluated different strains of broilers at 49 days of age, and found that Cobb 500 had feed intake 9% lower compared to Hubbard strain, without differing ($p > 0.05$) in weight gain. These differences may be associated with the genetic divergence existing among the main commercial genotypes operated in Brazil (Cobb 500, Ross 308 and Hubbard Flex) and with the variations in the pattern and growth curve of broilers, which can alter nutrient intake (Marcato et al., 2010; Veloso et al., 2015). However, when evaluating different strains, this variation may not be enough to cause significant changes in weight gain and feed efficiency. Lara et al. (2013) in a research of the effect of physical form of the feed and broiler strain observed that the Cobb 500 strain showed higher ether extract digestibility ($p < 0.05$) compared to the Ross 308. A more efficient digestibility of lipid fraction in the diet can result in lower consumption, due to increased energy satiety from a smaller amount of feed ingested.

Table 2. Average values of feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) from commercial strains of broilers fed diets supplemented with different levels of digestible lysine in the period of 49 to 56 days.

	FI (g $bird^{-1}$)	WG (g $bird^{-1}$)	FCR (g g^{-1})
	Digestible lysine levels (%)		
0,800	1844	918	2.011
0.950	1839	890	2.076
1.100	1741	869	2.017
1.250	1860	917	2.043
	Commercial strains		
Cobb 500	1686 a	872	1.953
Hubbard Flex	1855 b	901	2.074
Ross 308	1920 b	923	2.097
CV (%)	7.63	9.79	9.101
SEM	19.24	21.35	0.05
	p – value		
Lysine levels (L)	0.9283	0.3871	0.7830
Strain (S)	0.0012	0.3780	0.1612
L x S	0.9391	0.6327	0.4964

CV = coefficient of variation (%); p - value = probability value; SEM = standard error of the means. L x S = interaction between lysine levels and strains. Means followed by different letters in the same column differ by Tukey test ($p < 0.05$).

Barbosa et al. (2001) found no differences ($p > 0.05$) between three different levels of digestible lysine (0.940, 1.040 and, 1.140%) for the production characteristics of broilers in the period from 42 to 56 days. Araújo et al. (2002) evaluated different amino acid profiles in broilers rations, using different nutritional plans, and observed superiority of Hubbard strain compared with HI-Yield, with improvement in weight gain without, however, changing the feed conversion ratio and feed intake. The recommendations of the appropriate levels of lysine are important, since from these pre-established values it will be calculated, consecutively, the inclusion of other crystalline essential amino acids to be supplied by the diet, by the ideal protein concept (Vieira & Angel, 2012). Consequently, it can increase the chances of reducing the crude protein of the diets, therefore providing less environmental impact. Thus, other relations with other amino acids are respected. This balance between lysine and other amino acids was not applied in the present study. Finally, as an effect of the balance between amino acids present in the diet, it is possible to experience a decrease in heat increment by lower supply of protein ingredients and, therefore, decreased energy expenditure by the bird, due to reduced excretion of excess nitrogen in the uric acid form.

Moreover, the increase of the level of digestible lysine in the diet without considering the relationship between the other amino acids can result in limited performance by deficiency of some other essential amino acid (Oliveira et al., 2014). Accordingly, when evaluating lysine levels for broilers at different stages of creation, it is essential to consider its relationship with other essential amino acids. Among these, it is possible to highlight the methionine, threonine and valine, which are respectively the first, the third and the fourth limiting amino acid for broilers in diets formulated on vegetable ingredients (Corzo, Loar, & Kidd, 2009; Tavernari et al., 2013). In addition, when there is a non-balance of essential amino acids provided in the feed, even the non-essential amino acids may become limiting to the maximum expression of the birds genetic potential (Oliveira Neto & Oliveira, 2009). After all, the imbalance in the amino acid concentration accelerates the deamination and transamination process with donation and/or degradation of their respective amino grouping. As a result, the amino acid that would be used for protein deposition is relocated for other metabolic functions such as maintenance of enzymes synthesis, amino acids and ammonia.

No interaction effect was observed between the carcass characteristics in study and lysine levels ($p > 0.05$) (Table 3). There was effect for the different evaluated commercial genotypes, being that the Cobb 500 strain showed higher breast yield and breast meat ($p < 0.05$), no differing in carcass yield between other strains. However, Hubbard Flex and Ross 308 strains showed better thigh and drumstick yields ($p < 0.05$) compared to the Cobb 500 strain.

Moreira et al. (2003) evaluated the main strains of broiler chickens exploited in Brazil (Ross, Cobb and, Hubbard) and found that there is no effect of genotype on carcass yield. However, Fernandes, Bortoluzzi, Triques, Garcez Neto, and Peiter (2013) found higher breast fillet yield ($p < 0.01$) in Cobb 500 strain compared to Ross 308 and Ross 508. According to Lara et al. (2008), Cobb 500 strain has less need for maintenance compared with the Ross 308 strain. This can lead to better use of metabolizable energy of feed for productive purposes, such as meat deposition, which at this stage focuses mostly on the breast of broiler chickens.

Marcato et al. (2010) showed that the broilers strains, although similar, differ between each other in growth behavior and development of organs responsible for deposition and synthesis of dietary nutrients.

Table 3. Average values of carcass yield (CY), breast yield (BY), breast meat yield (BMY), thigh and drumstick yield (TDY) from commercial strains of broilers fed diets supplemented with different levels of digestible lysine in the period of 49 to 56 days.

	CY (%)	BY (%)	BMY (%)	TDY (%)
	Digestible lysine levels (%)			
0,80	73.39	38.96	32.01	29.95
0.95	74.59	39.16	31.82	29.79
1.10	72.65	40.14	32.72	30.10
1.25	72.98	38.22	31.20	30.58
	Commercial strain			
Cobb 500	73.76 ab	40.78 a	33.42 a	29.14 b
Hubbard Flex	74.53 a	37.89 b	30.87 b	30.70 a
Ross 308	71.91 b	38.69 b	31.53 b	29.33 a
CV (%)	3.18	4.45	4.82	2.75
SEM	0.76	0.39	0.74	0.81
	p < value			
Lysine levels (L)	0.9230	0.8571	0.9945	0.7920
Strain (S)	0.0317	0.0014	0.0013	0.0002
L x S	0.9630	0.7895	0.9816	0.9285

CV = coefficient of variation (%); p - value = probability value; SEM = standard error of the means. L x S = interaction between lysine levels and strains. Means followed by different letters in the same column differ by Tukey test ($p < 0.05$).

Among the strains, Ross 308 strain has earlier liver development, while the Cobb 500 shows early development of intestine and proventriculus. Thus, it becomes indispensable the knowledge on the growth rates of the different genotypes over the interpretation of the allometric growth curves. After all, the grow rates identifies the potential of each genotype and assign selection pressure as the goal of every breeding program. Based on this, Fernandes et al. (2013) evaluated different strains of broiler chickens at different periods of slaughter and observed that the Cobb 500 strain showed a maximum growth potential after 47 days, whereas Ross 308 strain between 33 and 35 days. This may explain, partially, the variability in protein deposition between the strains under study. Araújo et al. (2002) evaluated different amino acid profiles in the ration, and observed an improvement in the yield of legs and lower chicken breast yield of Hubbard strain, compared to those of HI-Yield strain. Pavan et al. (2003) detected differences for breast meat yield with superiority of Cobb 500 compared to Ross 508 without, however, differing between each other in breast yield. From the assessed variables, it can be seen that there is a difference in the growth patterns between the strains, with different protein deposition in the evaluated cuts in final phase. According to Fatufe, Timmler, and Rodehutscord (2004) when comparing commercial strains of broilers, one should also take into account the type of genetic selection in the long-term, as also the possible changes in the ratio of muscle mass, the number and diameter of the fibers, digestion rate and intestinal absorption of amino acids.

In accordance with Araújo et al. (2005), when raising lysine levels in diets, this may lead to an

increase in performance and improvement in carcass yield and broiler breast, in the final phase. However, this fact occurs if the relationship between the lysine and other amino acids is respected, especially the sulfur-containing, as also the nitrogen balance of diets on this stage (Trindade Neto et al., 2009; Goulart et al., 2011). The mentioned balance between lysine and other amino acids was not applied in the present research.

Furthermore, other factors may contribute to increasing efficiency of lysine utilization for optimizing the production performance and meat deposition. Among them, it can be highlighted the metabolizable energy content and electrolyte balance of diets, sanitation status, temperature and environmental conditions, breed, sex and age of the birds (Campestrini et al., 2010; Meza et al., 2015). Thus, the short period of adjustment of lysine levels without maintaining the relationship with the other amino acids, combined with the maturity of the chickens that are usually slaughtered at younger ages, may also have contributed to the lack of effect on performance and carcass yield of the chickens. In this study, it was observed that only the strain, regardless of digestible lysine level adopted, contributed to influence the performance data and carcass characteristics.

Nowadays, there is a trend in the poultry industry, to commercialize cuts and post-processed products over the whole carcass. This is done by the earned value of the cuts and also by the quality demand and convenience in food preparation by the consumer. Thus, the breast becomes the most important section as it represents about 50% of the total protein of chicken (Almeida et al., 2002); with more ability to produce food derived as seasoned products, pre-cooked and frozen. Accordingly, for the creation of chickens after 49 days old, the Cobb 500 strain may become more attractive to the broiler industry integrators, since it obtained the lower feed intake and higher breast yield and breast meat when compared to the strains Ross 308 and Hubbard Flex.

From the performance data and carcass characteristics observed in this study, it can be inferred that the lowest level of digestible lysine, 0.800%, is appropriate to the phase 49-56 days. This level is lower than those reported by Barbosa et al. (2001); Trindade Neto et al. (2009) and Rostagno et al. (2011) by 0.940, 1.100 and 1.070%, respectively, for broilers of 42 to 56 days. Further studies should be conducted to ascertain the best level of digestible lysine in the final phase, as the effect associated with the relationship between the different commercial genotypes and between the other limiting digestible amino acids that contribute to the development and protein deposition. In addition, the formulation of feed by non-linear method with economical approach of crystalline amino acid sources to be supplemented, can contribute to bio-economic adjustment of the diet. After all, it correlates food costs and additives used in the formulation with the price paid for the product generated; in this case, the chicken meat.

Conclusion

The increase in lysine levels without maintaining the relationship with the other essential amino acids does not improve the performance and yield of broilers in the phase of 49 to 56 days. There are significant differences between strains for feed intake and carcass characteristics. Among them, the Cobb 500 strain demonstrated more breast and breast meat yield, and the strains Hubbard Flex and Ross 308 presented a higher yield for thigh and drumstick.

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