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Digestible lysine for barrows of genetic lines selected for meat deposition from 60 to 100 days of age

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ABSTRACT - In order to evaluate the effects of dietary digestible lysine levels on performance and carcass traits of two genetic lines of pigs selected for meat deposition, from 60 to 100 days of age, a total of 120 crossbred barrows, with initial average body weight of 25.42 ± 2.08 kg were used. Pigs were allotted in a complete randomized block design, within a 4 × 2 factorial arrangement (four digestible lysine levels: 0.90, 1.00, 1.10, and 1.20%, and two genetic lines: A and B), with five replicates and three pigs per pen, which was the experimental unit. There was no interaction between genetic and digestible lysine levels for any variable of performance and carcass traits assessed. There was also no effect of digestible lysine levels in feed intake, body weight gain, and feed conversion. Digestible lysine intake of pigs increased linearly with increasing digestible lysine levels in the diets. Except for carcass yield that increased quadratically up to 1.04% estimate level of digestible lysine, there was no effect of lysine levels on the other carcass traits assessed (loin and ham yield, and amount of meat in the carcass). The digestible lysine level of 0.90%, corresponding to an estimated daily intake of 19.10 g, meets the requirements of castrated male pigs selected for meat deposition from both genetic lines, from 60 to 100 days of age.

Key Words: amino acids, growing, nutrition, requirement

Introduction

Barrows with different genetic potential for lean tissue deposition have varied nutrient requirements and demand specific feeding strategies (Friesen et al., 1994). The assessment of the nutritional requirements of barrows from different genetic groups at specific production stages is essential to obtain the maximum expression of the genetic potential for meat production in livestock animals.

Modern genetic strains of pigs have great potential for muscle deposition, a feature that highly interferes in the demand of amino acids, especially lysine. Lysine is the first limiting amino acid in corn-soybean meal basal diet and it is directly responsible for muscle deposition due to its constancy in the body protein and its preferential deposition in lean tissues (Kessler, 1998). Therefore, performance and lean gain responses in pigs may be associated with the level of dietary lysine (Oliveira et al., 2003).

The continuous selection of pigs with high muscle deposition potential has resulted in an increased demand for digestible lysine (Loughmiller et al., 1998) and companies are constantly offering new and improved genetic strains with increased potential for meat production. Further studies to determine the requirements of digestible lysine for the new strains are, therefore, continually required to guarantee animal performance.

This study assessed the effect of lysine levels on performance and carcass characteristics of barrows from two genetic lines selected for meat deposition from 60 to 100 days of age.

Material and Methods

The experiment was conducted at Setor de Suinocultura in Departamento de Zootecnia, Universidade Federal de Viçosa (UFV), Viçosa, Minas Gerais, Brazil.

A total of 120 barrows selected for muscle deposition, with initial weight of 25.42 ± 2.08 kg, was allotted to a 4 × 2 factorial-randomized block design (4 lysine levels: 0.90, 1.00, 1.10 and 1.20% and 2 genetic lines: A and B), with five replicates and three pigs per experimental unit (pen). The criteria used for block formation were initial weight and genetic group.

The animals were housed in pens equipped with semi-automatic feeders and nipple drinkers, in a concrete floor facility with with ceramic tiling. Indoor temperature was

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daily measured (at 8 a.m.) with maximum and minimum thermometers.

Experimental diets (Table 1) were corn-soybean meals based supplemented with minerals and vitamins to meet the nutritional requirements for this animal category, except for lysine, according to Rostagno et al. (2005).

Treatments consisted of a basal diet and 3 diets supplemented with different levels of L-lysine HCL in replacement of starch.

Ratios between lysine and other amino acids in the diets were checked in all treatments to guarantee that no other amino acid was limiting in the diet. The assessment of the amino acids ratios in the diets was done using the ratios recommended by Rostagno et al. (2005) in the ideal protein concept for growing barrows.

The animals received water and experimental diet *ad libidum* during the experimental period. They were weighed at the beginning and at the end of the experiment (60 and 100 days, respectively) to determine average daily feed intake, average daily weight gain, feed conversion and digestible lysine intake. Daily feed waste was weighed to calculate feed and digestible lysine intake.

At the end of the experiment, after 24 hours of fasting, one pig from each experimental unit with body weight closest to the average weight of the block was exsanguinated, shaved and eviscerated. The carcasses was then processed to estimate carcass yield (expressed as percentage of hot carcass weight in relation to body weight after fasting), ham yield (expressed as percentage of the total ham weight in relation to chilled half-carcass weight), loin yield (expressed as percentage of total loin weight in relation to chilled half-carcass weight). Meat yield was obtained by applying value of 'Y' on the equation: $Y = 15.32 + (1.272 * THM) + (1.654 * TCM)$ on the carcass weight, where THM is the total ham meat percentage (primary cuts + flaps and muscle) and TCM is the total carré meat percentage (loin and flaps).

Data were analyzed using procedures for analysis of variance and regression in the System for Statistics and Genetics (SAEG), developed at the Universidade Federal de Viçosa (UFV, 2000), version 9.0. A 0.05 critical level of probability for type I error was used for all statistical procedures.

Results and Discussion

The maximum and minimum mean temperatures registered inside the facility were 14.7 ± 2.24°C and 21.1 ± 1.83°C, respectively. Considering the ideal temperature range from 16 to 24°C for pigs in the growing

Table 1 - Percentage and calculated composition of experimental diets

Ingredient	Digestible lysine levels (%)			
	0.90	1.00	1.10	1.20
Corn	63.888	63.888	63.888	63.888
Soybean meal	30.000	30.000	30.000	30.000
Soybean oil	1.000	1.000	1.000	1.000
Starter nucleus[1]	4.000	4.000	4.000	4.000
Starch	1.100	0.883	0.596	0.210
L–lysine HCl	-	0.120	0.247	0.375
DL–methionine	0.012	0.057	0.120	0.188
L–threonine	-	0.052	0.120	0.188
L–tryptophan	-	-	0.019	0.038
L–isoleucine	-	-	0.010	0.068
L–valine	-	-	-	0.051
Butyl-hidroxy-toluene	0.010	0.010	0.010	0.010
Calculated nutritional composition[2]				
ME (kcal/kg)	3200	3200	3200	3200
Crude protein (%)	18.973	18.973	18.973	18.973
Digestible lysine (%)	0.907	1.000	1.100	1.200
Digestible tryptophan (%)	0.190	0.190	0.209	0.228
Digestible met + cis (%)	0.564	0.622	0.684	0.746
Digestible threonine (%)	0.619	0.670	0.737	0.804
Digestible isoleucine (%)	0.617	0.617	0.627	0.684
Digestible valine (%)	0.801	0.801	0.801	0.801
Calcium (%)	0.665	0.665	0.665	0.665
Available phosphorus (%)	0.345	0.345	0.345	0.345

[1] Provided per kg of product: vitamin A – 93,000 UI; vitamin D3 – 24,000 UI; vitamin E – 106 mg; vitamin K3 – 53 mg; thiamin – 13.3 mg; pantothenic acid – 173 mg; biotin – 0.42 mg; pyridoxine – 13.3 mg; vitamin B6 HCl – 8.8 mg; folic acid – 520 µg; vitamin B12 – 7.000 mg; calcium (minimum) - 112 g; phosphorus (minimum) – 27 g; sodium – 58.5 g; iron – 1,820 mg; zinc – 2,049 mg; copper – 2,126 mg; manganese – 836 mg; iodine – 29.5 mg; fluorite (maximum) – 485 mg; selenium – 8 mg; cobalt – 3.6 mg.
[2] Values estimated based on the digestibility coefficients of amino acids of ingredients, according to Rostagno et al. (2005).

phase (30 to 60 kg) suggested by Coffey et al. (2000), the pigs in this study did not go through heat stress.

No interaction was found (P>0.05) between the levels of lysine and genetic lines in relation to performance and the carcass traits evaluated.

No effect (P>0.05) of the levels of digestible lysine on daily feed intake (DFI) was observed and there was no variation (P>0.05) in DFI between animals from different genetic lines (Table 2), showing that the DFI was not a variable between different genetic lines. The absence of effect of the levels of lysine in diets on the DFI of growing pigs (30 to 60 kg) was also observed by several authors (Fontes et al.,2000; Gasparotto et al., 2001; Abreu et al., 2007; Souza et al., 2008, Main et al., 2008; Zangeronimo et al., 2009; Fortes, 2009).

According to Ettle & Roth (2004), pigs are able to recognize diets containing different concentrations of tryptophan and prefer those with the most appropriate levels of this amino acid, showing increased consumption. However, the consistency of the studies on the absence of effect of lysine levels on the DFI of pigs shows that, unlike tryptophan, pigs do not change their consumption to meet lysine requirements. In agreement with this proposition, Owen et al. (1994) evaluated diets with different lysine levels (0.50, 1.10, and 1.60%) in a free choice feeding system and found that pigs were unable to regulate consumption according to lysine concentration.

This is in agreement with the report by Edmonds & Baker (1987), who showed that pigs can tolerate a considerable excess of amino acids in the diet, especially lysine, with no significant variation in consumption.

D'Mello (1993) and Kerr et al. (2003) have shown that diets with unbalanced amino acids can result in reduced intake by pigs. This unbalance may have been avoided in this study by diet supplementation with synthetic amino acids, keeping the ratios between these amino acids and lysine.

A significant effect (P<0.01) of digestible lysine levels on daily lysine intake (DLI) of animals was observed (Table 2) with linear increase, according to the equation $\hat{Y} = 3.2309 + 18.0837X$ ($r^2 = 0.95$). Other authors (Abreu et al., 2007; Fortes, 2009) have observed linear increase of lysine consumption in growing pigs (30 to 60 kg) as a result of increasing levels of this amino acid in diets. In this study, the daily diet intake of animals had no significant variation among treatments, so the linear increase observed in the DLI can be explained by the concentration of this amino acid in the diet.

The levels of lysine had no influence (P>0.05) on the daily weight gain (ADG) of animals, regardless of genetic line (Table 2). Several authors in studies with growing pigs have also reported no influence of dietary lysine levels on ADG (Maiden et al. 1994; Souza, 1997, Fontes et al., 2000, Fontes et al. 2005; Abreu et al. 2007; Fortes, 2009; Zangeronimo et al., 2009).

However, Warnants et al. (2003) and Main et al. (2008) assessed pigs from 30 to 50 kg and from 43 to 70 kg, respectively, and found that animal weight gain showed quadratic increase up to the highest estimated levels of digestible lysine (0.91 and 1.09%).

The amino acid demands of pigs can be affected by different factors such as ambient temperature and immune challenge levels (Williams et al., 1997; Braumann et al., 2002; LeFloc'h et al., 2004; Trevisi et al., 2009). Besides these factors, the inconsistency in the daily weight gain response resulting from the lysine levels observed among the studies may be related to differences in the genetic potential for lean gain of pigs. According to Sthaly et al. (1994), the response of ADG to dietary lysine level depends on the animal genotype and growth potential. Yen et al. (1986) affirms that performance and carcass meat deposition responses may be associated with the level of dietary lysine demand due to a higher demand of this amino acid for protein deposition and its high concentration in the muscle tissue of pigs.

Consistent with these assertions, Gasparotto et al. (2001) evaluated the lysine requirement of barrows from two genetic groups (genetically improved and common groups), from 24-50 kg and found that lysine levels of 1.00 and 0.75% met

Table 2 - Performance of barrows from 60 to 100 days of age in relation to the level of lysine in diets

Variable	Digestible lysine level, %				Genetic		CV, %
	0.90	1.00	1.10	1.20	A	B	
Initial body weight, kg	25.63	25.40	25.40	25.27	25.67	25.22	0.14
Final body weight, kg	65.66	65.89	66.07	65.21	65.18	66.17	2.73
Daily weight gain, g	1000	1012	1017	998	988	1024	4.26
Daily feed intake, g	2156	2114	2157	2048	2114	2123	4.79
Feed conversion, g/g	2.15	2.09	2.12	2.05	2.14	2.08	3.73
Daily digestible lysine intake, g[1]	19.56	21.14	23.72	24.60	22.14	22.30	4.74

[1] Linear (P<0.05); CV = Coefficient of variation.

the animals' requirements of both groups (improved and common, respectively).

No significant variation in weight gain in animals from different genetic strains was observed in this study. This may have contributed to the fact that there was no difference in the digestible lysine requirements between them.

No significant differences were found between ADI and ADG of the animals, that is why no effect was observed (P>0.05) for dietary lysine levels in diets on feed conversion (Table 2), in spite of genetics. Similar results of feed conversion obtained in this study were found by Gasparotto et al. (2001), Haese et al. (2006) and Strong (2009) who evaluated lysine levels in diets for barrows from 30 to 60 kg, and also found no significant effect on this variable.

The effects of lysine levels on the performance of growing pigs were investigated by Fontes et al. (2000), Warnants et al. (2003), Oliveira et al. (2006), Abreu et al. (2007), Main et al. (2008) and Zangeronimo et al. (2009), who reported significant variation in feed conversion, as a function of dietary lysine concentrations in diets.

From the performance results obtained in the present study it can be affirmed that pigs from the different genetic lines showed similar weight gain potential and feed efficiency, which explains the absence of significant interactions between levels of lysine and genetics.

The 0.90% level of digestible lysine, corresponding to a daily intake of 19.0 g (genetic A) and 19.1 g (genetic B), meets the requirements of ADG and feed conversion of both genetic groups and is consistent with the 19.12 g/d value proposed by Rostagno et al. (2005) for growing barrows (30 to 50 kg) with high genetic potential. However, this value (0.90%) is higher than the level of 0.80% digestible lysine, intake of 16.6 g, obtained by Fortes (2009) in a study with pigs from two genetic lines selected for lean deposition between 63 and 103 days of age.

The digestible lysine levels influenced (P<0.05) carcass yield (CY) (Table 3), showing a quadratic increase up to the highest level of 1.04% lysine (Figure 1). Genetic group had no influence on this variable. Yen et al. (2005) and Abreu et al. (2007) also found positive responses on carcass yield of pigs in relation to dietary lysine concentrations in studies with finishing pigs. However, Cromwell et al. (1993), Friesen et al. (1994) and De La Llata et al. (2002) found no influence of levels of dietary lysine on carcass traits of pigs.

Lysine levels had no influence (P<0.05) on loin and ham yield (Table 3). Similar results were obtained by Cromwell et al. (1993), Souza Filho et al. (1999), De La Llata et al. (2002) and Abreu et al. (2007), who assessed lysine levels for growing and finishing barrows and found no effect of dietary lysine levels on the loin-eye area and depth or on loin and ham yield. Likewise, Fabian et al. (2001) and Kendall et al. (2001), in studies with pigs weighing 50-80 kg and 70-93 kg, respectively, found that the levels of lysine did not influence animal carcass traits.

The levels of dietary lysine had no effect (P>0.05) on the meat content of carcass (Table 3). Similarly, Abreu et al. (2007) evaluated levels of digestible lysine on carcass traits from pigs weighing 60 to 95 kg and found no effect on lean meat

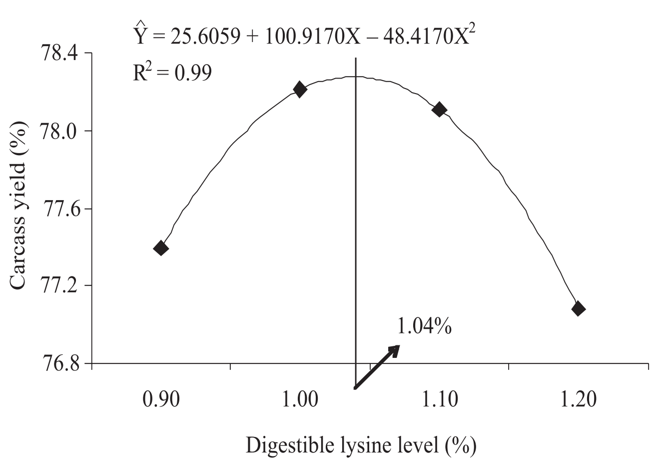

Figure 1 - Effect of digestible lysine levels in diets on carcass yield of barrows from 60 to100 days of age.

Table 3 - Carcass traits for barrows between 60 and 100 days of age, as a function of digestible lysine levels in diet

Variable	Digestible lysine level, %				Genetic line		CV, %
	0.90	1.00	1.10	1.20	A	B	
Carcass yield (%)[1]	77.39	78.21	78.11	77.08	78.21	77.30	1.63
Loin yield (%)	5.62	5.80	5.36	5.70	5.62	5.63	6.72
Ham yield (%)	30.73	31.35	30.82	30.45	30.64	31.04	2.95
Total ham meat (%)[2]	19.80	20.44	19.65	20.10	19.76	20.24	-
Total carré meat (%)[3]	8.32	8.59	8.43	8.59	8.50	8.47	-
Amount of meat (kg)[4]	26.36	27.20	26.34	26.63	26.47	26.81	6.07

[1] Quadratic (P<0.05).
[2] Total ham meat percentage (main cuts + flaps and muscle).
[3] Total carré meat percentage (loin and flaps).
[4] Obtained by applying the 'Y' value from the equation Y = 15.32 + (1.272*THM) + (1.654*TCM) on the carcass weight.
CV = Coefficient of variation

yield. Fontes et al. (2000), who assessed gilts from 30 to 60 kg and Kill et al. (2003), in a study with finishing pigs, also found no effect of lysine levels on the muscle growth rate of pigs.

On the other hand, Oliveira et al. (2006), Abreu et al. (2007) and Nunes et al. (2008) found significant effect of the dietary lysine levels on protein deposition in the carcass of growing barrows (6 to 60 kg). According to Kill et al. (2003) and Abreu at al. (2007), the inconsistency of the results found in studies examining the effects of increasing levels of dietary lysine on carcass traits of pigs may be related, among other factors, to the genotypic differences concerning meat deposition potential. This is in agreement with the results found by Gasparotto et al. (2001) and Moreira et al. (2002), who evaluated the lysine requirement of barrows from two genetic groups (common and improved) from 24 to 50 kg and 50 to 90 kg, respectively. They found that the levels of lysine influenced loin-eye area and depth, which varied between the genetic groups.

Assessing the influence of genotype, sex and lysine levels on carcass quality of pigs, Unruh et al. (1996) found that the increase in lysine concentration had minimal effects on carcass traits, which is consistent with the results of carcass traits obtained in this study.

Conclusions

The 0.90% level of digestible lysine, corresponding to a daily intake of 19.10 g, meets the requirements of 60-100-day-old barrows selected for meat deposition, from both genetics.

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