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Net energy and ractopamine levels for barrows weighing 70 to 100kg

Níveis de energia líquida e ractopamina para suínos machos castrados dos 70 aos 100kg

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ABSTRACT

The purpose of this study was to evaluate net energy and dietary ractopamine levels for barrows weighing 70 to 100kg. The 150 pigs investigated (initial weight 70.80±3.84kg) were distributed in a randomized block design with a 5×3 factorial arrangement, comprising five levels of net energy (2,300; 2,425; 2,550; 2,675; and 2,800Kcal kg^{-1} of diet) and three levels of ractopamine (5, 10, and 20ppm kg^{-1} of diet), with five replicates, and two animals per experimental unit. No interaction (P>0.05) was observed between net energy and ractopamine levels. Increasing the dietary net energy levels led to a linear reduction in feed intake, with a linear improvement in feed conversion. Net energy levels had no observable effect (P>0.05) on weight gain, final weight, or carcass characteristics. A dietary net energy level of 2,800Kcal kg^{-1} can be recommended for pigs weighing 70-100kg, improving feed conversion without affecting carcass characteristics, regardless of dietary ractopamine levels. Ractopamine levels above 5ppm did not affect performance or modify the quantitative characteristics of carcasses, regardless of dietary net energy levels.

Key words: *carcass, energy requirement, nutrition.*

RESUMO

Conduziu-se este estudo com o objetivo de avaliar níveis de energia líquida e ractopamina na dieta de suínos machos castrados em terminação dos 70 aos 100kg. Foram utilizados 150 suínos, com peso inicial de 70,80±3,84kg, distribuídos em delineamento de blocos ao acaso, em esquema fatorial 5x3, com cinco níveis de energia líquida (2.300, 2.425, 2.550, 2.675 e 2.800Kcal kg^{-1} de dieta) e três níveis de ractopamina (5, 10 e 20ppm kg^{-1} de dieta), cinco repetições e dois animais por unidade experimental. Não houve interação (P>0,05) entre os níveis de energia líquida e ractopamina. O aumento dos níveis de energia líquida das dietas proporcionou redução linear do consumo de ração e resultou em melhora linear da conversão alimentar. Não houve efeito (P>0,05) dos níveis de energia líquida no ganho de peso, peso final e nas características de carcaça. Recomenda-se o nível de 2.800Kcal de EL kg^{-1} de dieta para suínos de 70 a 100kg por melhorar a conversão alimentar, sem prejudicar as características de carcaça, independentemente do nível de ractopamina das dietas. A inclusão de ractopamina na dieta de suínos dos 70 aos 100kg não afeta o desempenho e não modifica as características quantitativas das carcaças, independente do nível de energia líquida das dietas.

Palavras-chave: *carcaça, exigência energética, nutrição.*

INTRODUCTION

Full expression of the potential of swine of high genetic standard requires diets that meet the animal nutritional requirements. One approach to achieve maximum feed efficiency and carcass quality is the addition of ractopamine to the diets of finishing pigs.

Ractopamine has been shown to improve performance and carcass characteristics (CORASSA et al., 2009) without affecting meat quality (ALMEIDA et al., 2010), while increasing daily weight gain, improving feed conversion, and reducing back-fat thickness, and increasing ribeye area, meat percentage, and carcass meat-to-fat ratios.

In swine, lysine concentrations in deposited protein are higher when diets are supplemented with ractopamine. However, the lysine-to-energy ratios and energy levels required for optimizing performance and carcass characteristics are higher than those recommended in the literature addressing dietary ractopamine (APPLE et al., 2004).

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Reassessing the energy levels of diets supplemented with ractopamine is critical, since constraints to ractopamine activity may limit full expression of productive potential in swine.

The purpose of this study was to evaluate the effect of net energy and ractopamine levels, as well as their interaction, on the performance and carcass characteristics of finishing barrows weighing 70 to 100kg.

MATERIALS AND METHODS

One hundred and fifty barrows of a commercial line exhibiting high potential for protein deposition were used in this study. Mean initial weight was 70.80±3.84kg. Animals were distributed in a randomized block design with a 5×3 factorial arrangement, comprising five levels of net energy (2,300; 2,425; 2,550; 2,675; and 2,800Kcal kg^{-1} of diet) and three levels of ractopamine (5, 10, and 20ppm kg^{-1} of diet), with five replicates, and two animals per experimental unit. Blocks were based on initial weight. The animals were housed in pens equipped with semi-automatic feeders and bite nipple drinkers, located in a masonry shed roofed with ceramic tiles.

The experimental diets (Table 1), prepared with soybean meal and corn, were supplemented with amino acids, minerals, and vitamins to meet the nutritional requirements proposed by ROSTAGNO et al. (2011) for barrows of high genetic potential and superior performance weighing 70 to 100kg. Dietary net energy was calculated based on the mean composition of raw materials (ROSTAGNO et al., 2011). Different energy levels were obtained by replacing kaolin with soybean oil while maintaining an optimal protein pattern across diets. Feed and water were provided *ad libitum* throughout the 30-day experimental period.

Animals were weighed at the beginning and end of the experiment. Weights of supplied feed, leftovers, and wastage were employed to calculate lysine and daily net energy intakes, as well as, daily weight gain and feed conversion for each experimental unit.

Following the final weighing, animals were transported to a commercial abattoir where they remained in stall rest with access to water, but without solid food, for 10h. For slaughter, the animals were subjected to electronarcosis and subsequently bled, scalded, and eviscerated.

At the end of the slaughter line, the heads were removed, carcasses halved lengthwise, and half-carcasses weighed individually. Left half-carcass was cut at P2 (the point corresponding to the orthogonal projection of the last rib 4cm from the spine) to expose the *Longissimus dorsi* and back-fat layer for measurements of muscle depth and back-fat thickness using digital calipers, before carcass temperature reduced.

Calculations of meat percentage and lean meat amount were based on hot carcass weight, back-fat thickness, and muscle depth using the equations proposed by BRIDI & SILVA (2007): lean meat percentage (%) = 60 - (back-fat thickness × 0.58) + (muscle depth × 0.1); lean meat amount (kg) = (hot carcass weight × lean meat percentage)/100.

Performance variables (weight gain, feed, energy intake, and feed conversion) and quantitative carcass traits (hot carcass weight, back-fat thickness, muscle depth, and carcass meat percentage) were subjected to analysis of variance (general linear model), using SAS software version 9.0. A 5% significance level was adopted. Initial weight was used as a covariate in the statistical model. Models of best fit were applied using linear and/or quadratic regressions to net energy and ractopamine levels.

RESULTS AND DISCUSSION

No effect of interaction (P>0.05) between net energy and ractopamine levels (Table 2) was observed on performance variables, corroborating the results obtained by MOURA et al. (2011a), who reported no effect of interaction between net energy (2,300; 2,424; 2,548; and 2,668Kcal kg^{-1}) and ractopamine levels (0 and 20ppm) on the performance of finishing gilts subjected to high ambient temperatures.

No influence of net energy levels of the experimental diets was observed on final body weight (P>0.05), but feed intake decreased linearly (P<0.01) with increasing energy levels, a result explained by the fact that pigs can modify feed intake to adjust to dietary energy levels (REZENDE et al., 2006) the higher the dietary energy, the lower the voluntary feed intake. Therefore, finishing pigs provided diets with high energy densities, reduced voluntary consumption, and such diets have been associated with improved feed efficiency. The result corroborated the findings reported by KIL et al. (2011) for net energy levels of 2,056; 2,206; and 2,318Kcal kg^{-1} and by QUINIOU & NOBLET (2012) for 3,100; 3,230; 3,370; and 3,500Kcal kg^{-1}.

Table 1 - Composition of experimental diets.

	Net energy (Kcal kg^{-1} of diet)				
Ingredients	2,300	2,425	2,550	2,675	2,800
Corn	70.15	70.15	70.15	70.15	70.15
Soybean meal (45%)	20.44	20.44	20.44	20.44	20.44
Soybean oil	0.000	1.697	3.394	5.091	6.800
Inert matter (kaolin)	6.800	5.103	3.406	1.709	0.000
Dicalcium phosphate	0.832	0.832	0.832	0.832	0.832
Calcitic limestone	0.445	0.445	0.445	0.445	0.445
Vitamin and mineral supplement[1]	0.100	0.100	0.100	0.100	0.100
Salt	0.305	0.305	0.305	0.305	0.305
L-lysine HCl	0.451	0.451	0.451	0.451	0.451
DL-methionine	0.159	0.159	0.159	0.159	0.159
L-threonine	0.177	0.177	0.177	0.177	0.177
L-tryptophan	0.037	0.037	0.037	0.037	0.037
Ractopamine or inert matter[2]	0.100	0.100	0.100	0.100	0.100
Calculated nutritional values					
Net energy (Kcal kg^{-1})	2,300	2,425	2,550	2,675	2,800
Metabolizable energy (Kcal kg^{-1})	3,045	3,186	3,327	3,468	3,608
Gross protein (%)	16.00	16.00	16.00	16.00	16.00
Digestible lysine (%)	1.000	1.000	1.000	1.000	1.000
Digestible methionine + cystine (%)	0.617	0.617	0.617	0.617	0.617
Digestible threonine (%)	0.667	0.667	0.667	0.667	0.667
Digestible tryptophan (%)	0.187	0.187	0.187	0.187	0.187
Calcium (%)	0.484	0.484	0.484	0.484	0.484
Available phosphorus (%)	0.248	0.248	0.248	0.248	0.248
Sodium (%)	0.160	0.160	0.160	0.160	0.160

[1]Content per kilogram of diet: vit. A, 1 250 000IU; vit. D_3, 250 000IU; vit. E, 6250IU; vit. K_3, 750mg; vit. B_1, 375mg; vit. B_2, 1000mg; vit. B_6, 375mg; vit. B_{12}, 4500µg; niacin, 4500mg; pantothenic acid, 2300mg; folic acid, 125mg; iron, 25g; copper, 3750mg; manganese, 12.5g; zinc, 31.25g; iodine, 250mg; selenium, 75mg; excipient q.s.p. 1000g. [2]Ractopamine hydrochloride instead of kaolin.

No effect (P>0.05) of net energy levels on daily weight gain was observed. This response is possibly associated with the linear reduction in feed intake with increasing dietary energy levels. Similar results were reported by APPLE et al. (2004) for barrows and gilts and by MOURA et al. (2011a) for finishing gilts.

Feed conversion improved linearly (P<0.01) with increasing net energy levels. This result can be explained by the positive effects on nutrient digestibility of the oil used as an energy source, as well as by possible improvement in dietary energy-to-protein ratios. Similar results were obtained by PAIANO et al. (2008), who observed that feed conversion improved in finishing barrows and gilts fed diets with increasing net energy concentrations (2,410; 2,450; 2,490; 2,530; and 2,570Kcal kg^{-1}), and by YI et al. (2010) who investigated the effects of net energy levels (2,250; 2,300; 2,400; and 2,450Kcal kg^{-1}) in diets fed to pigs with 20-30kg live weight.

Moreover, ractopamine levels in the experimental diets did not affect performance variables (P>0.05). This absence of effect may be related to the range of body weights (70-100kg) in the experimental period, as prior research has demonstrated the benefits of ractopamine addition to the diets of pigs weighing over 100kg at slaughter time, particularly in terms of weight gain (CORASSA et al., 2009) and feed conversion (ALMEIDA et al., 2010). Genotypic features may be another reason why ractopamine did not affect performance, since variability in the genetic materials employed in different studies may affect the variables evaluated (HINSON et al., 2011).

No effect of interaction (P>0.05) between net energy and ractopamine levels was observed on carcass characteristics (Table 3). In addition, no effect of net energy levels (P>0.05) was observed on the quantitative characteristics of carcasses. These results suggested that the experimental diets

Table 2 - Performance of finishing barrows fed diets supplemented with ractopamine.

Var	Rac (ppm)	--------------------------NE (Kcal kg-1)--------------------------					Mean	---------------P-value---------------			CV (%)
		2.300	2.425	2.550	2.675	2.800		NE	Rac	Int.	
FW (kg)	5	95.42	94.46	94.68	95.25	95.61	95.10				
	10	99.73	98.90	98.43	97.86	96.87	98.36				
	20	96.28	99.54	94.84	96.89	95.25	96.56				
	Mean	97.14	97.63	96.07	96.67	95.91	–	0.830	0.206	0.926	4.73
DFI (kg)	5	2.34	2.27	2.21	2.09	2.06	2.19				
	10	2.46	2.30	2.34	2.33	1.98	2.28				
	20	2.36	2.45	2.11	2.14	1.99	2.21				
	Mean	2.38	2.34	2.22	2.19	2.01	–	0.013*	0.558	0.878	13.72
NEI (kcal)	5	5376	5519	5616	5598	5777	5576				
	10	5653	5564	5976	6245	5537	5795				
	20	5417	5937	5373	5729	5558	5603				
	Mean	5482	5673	5658	5857	5624	–	0.780	0.565	0.873	13.86
DWG (kg)	5	0.81	0.8	0.79	0.84	0.83	0.82				
	10	0.93	0.92	0.9	0.89	0.86	0.90				
	20	0.86	0.97	0.81	0.88	0.83	0.87				
	Mean	0.87	0.89	0.84	0.87	0.84	–	0.843	0.125	0.945	17.67
FC	5	2.94	2.91	2.82	2.49	2.49	2.73				
	10	2.65	2.5	2.61	2.72	2.29	2.55				
	20	2.77	2.55	2.62	2.45	2.42	2.56				
	Mean	2.79	2.65	2.68	2.55	2.4	–	0.013*	0.147	0.875	13.73

Var: variable; Rac: ractopamine (ppm); NE: net energy; CV: coefficient of variation; FW: finishing weight; DFI: daily feed intake; NEI: net energy intake; DWG: daily weight gain; FC: feed conversion; *LE: linear effect (P<0.05); DFI = 4.02127-0.00072x; FC = 4.44195-0.00069707x.

provided the nutritional input required for the expression of productive potential. Similar results were obtained by MOURA et al. (2011a) for hot carcass weight and dressing percentage and by PAIANO et al. (2008) for hot carcass weight and yield. QUINIOU & NOBLET (2012), however, observed higher dressing percentages in barrows for net energy levels of 1,935; 2,078; 2,221; 2,365; 2,508; and 2,651Kcal kg^{-1}.

Net energy levels did not influence either muscle depth or back-fat thickness (P>0.05). This finding corroborates the results observed for net energy intake, which did not vary across diets, indicating that energy intake was regulated by dietary energy content-*i.e.*, constant energy concentration resulted in uniform quantitative compositions of carcasses. MOURA et al. (2011b) obtained similar results for muscle depth and DE LA LLATA et al. (2001) and REZENDE et al. (2006) for back-fat thickness.

Lean meat percentage was affected (P>0.05) by net energy levels. These findings are similar to those obtained by REZENDE et al. (2006), PAIANO et al. (2008), and QUINIOU & NOBLET (2012), demonstrating the ability of pigs to adjust feed intake even in the presence of wide variability in dietary net energy concentrations, resulting in carcasses with consistently similar protein deposition patterns.

Ractopamine levels had no effect (P>0.05) on carcass characteristics. The literature reports a positive effect of ractopamine on carcass characteristics, particularly in decreasing back-fat thickness; this effect is explained by the ability of this compound to reduce fatty acid synthesis in adipose tissue and to increase protein synthesis in muscle tissue (SANCHES et al., 2010). In the present study, however, ractopamine levels had no effect on back-fat thickness, corroborating results obtained by HINSON et al. (2011).

MOURA et al. (2011a) reported that the effectiveness of ractopamine in reducing lipogenesis in porcine adipose tissue is more pronounced when diets have higher energy content, particularly in the form of lipids. Nonetheless, this response was not observed in the present study-even with the increased net energy levels provided by lipid supplementation, back-fat thickness was unaffected, possibly because net energy consumption remained constant.

Table 3 - Carcass characteristics of finishing barrows fed diets supplemented with ractopamine.

Var	Rac (ppm)	-------------------------NE (Kcal kg^{-1})------------------------					Mean	---------------P-value--------------			CV (%)
		2.300	2.425	2.550	2.675	2.800		NE	Rac	Int.	
HCW (kg)	5	70.42	70.60	69.70	70.42	71.08	70.44				
	10	74.30	72.56	73.64	72.34	72.70	73.25				
	20	70.02	71.20	69.60	71.18	69.68	70.34				
	Mean	71.58	71.45	70.98	71.31	71.15	–	0.997	0.062	0.995	6.49
MD (mm)	5	76.60	74.86	73.36	78.67	70.99	74.90				
	10	75.78	70.84	69.77	75.13	70.17	72.34				
	20	77.31	71.09	77.05	72.57	73.43	74.29				
	Mean	76.56	72.26	73.39	75.46	71.53	–	0.210	0.348	0.757	9.18
BFT (mm)	5	12.98	11.46	11.67	14.02	12.95	12.62				
	10	11.00	12.87	13.61	13.61	12.75	12.77				
	20	13.32	12.44	14.32	10.47	11.35	12.38				
	Mean	12.43	12.26	13.20	12.70	12.35	–	0.900	0.900	0.341	24.16
LMP (%)	5	60.13	60.84	60.57	59.74	59.59	60.17				
	10	61.20	59.62	59.09	59.62	59.62	59.83				
	20	60.01	59.89	59.4	61.18	60.76	60.25				
	Mean	60.45	60.12	59.68	60.18	59.99	–	0.861	0.706	0.556	3.16

Var: variable; Rac: ractopamine; NE: net energy; CV: coefficient of variation; HCW: hot carcass weight; MD: muscle depth; BFT: backfat thickness; LMP: lean meat percentage.

CONCLUSION

A dietary net energy level of 2,800Kcal kg^{-1} is proposed for pigs weighing 70-100kg, improving feed conversion without affecting carcass characteristics, regardless of dietary ractopamine levels. Ractopamine levels above 5ppm did not affect performance or modified the quantitative characteristics of carcasses, regardless of dietary net energy levels.

BIOETHICS AND BIOSSECURITY COMMITTEE APPROVAL

The investigation complied with ethical standards and was approved by the Ethics Committee on Animal Use (permit 429/2012) of the Universidade Federal de Mato Grosso do Sul (UFMS).

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