Nutri·Time

Revista Eletrônica

Vol. 15, Nº 05, set/out de 2018
ISSN: 1983-9006
www.nutritime.com.br

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Ractopamine for high genetic potential barrows in finishing phase

Carcass, performance, β-adrenergic agonist, swine, pig.

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ABSTRACT

The objective of this trail was to evaluate the performance and carcass characteristics of high genetic potential barrows, supplemented or not with 10 ppm ractopamine (RAC) during 23 days pre-slaughter. The seventy-two heaviest barrows of a commercial lineage of high genetic potential were selected from a group containing 210 animals. A randomized complete block design with two treatments was used: addition of 10 ppm of ractopamine and control without inclusion of RAC in the diet. Animals received *ad libitum* feed until the end of the experimental period. The pigs were weighed at the beginning of the experiment (117 days of age) and at the end (139 days of age), in these moments the animals had the backfat thickness and loin eye area measured trough ultrasound.

The pigs were slaughtered and carcass weight, dressing, carcass length, carcass compactness were evaluated. *Longissimus dorsi* muscle was evaluated for pH and temperature. The data were submitted to analysis of variance, adopting a level of significance at 5% compared with the F test. Pigs that received RAC presented lower average daily feed intake (7.2%) and improved feed conversion (8.5%) compared to pigs from the control
group. It is concluded that the addition of 10 ppm of ractopamine in the feed of high genetic potential barrows is advantageous.

Keyword: carcass, performance, β-adrenergic agonist, swine, pig.

INTRODUCTION

Considering the animal protein market, pork is the most widely consumed protein source in the world. In 2016, 109.554 million tons of pork were consumed, almost double the consumption of beef that reached 58.739 million tons, according to the US Department of Agriculture (USDA, 2017). In Brazil, this consumption is lower, being the third most consumed among Brazilians, emphasizing the great growth potential of swine production in the country.

Consumers seek low-fat meat cuts - whether for health or esthetics – being a challenge for the swine production system, which is due to the fact that animals in the finishing phase have high feed intake to produce pork and thus, have low feed efficiency. The animals increase the consumption capacity and exceed the amount of nutrients needed to reach their maximum potential, consequently increase the deposition of fat in the carcass, thus, producers must meet the demands of consumers, searching for technologies that improve the performance of animals to stay in the market.

In all segments of animal husbandry, which are intended for human consumption, and especially in the finishing phase, it is desired that the animals present maximum weight gain in a shorter time, consuming as little feed as possible. In this way, animal nutrition seeks technological solutions capable of promoting improvements in these performance variables, as well as in the quantitative and qualitative characteristics of the pig carcass.

The current producers must take into account that they are inserted in a market full of competitiveness, therefore, it is imperative that the final product is adapted to the pattern of consumption. Thus, the use of the so-called growth promoters, especially in the finishing phase, has become a viable alternative within the swine industry, since they improve the performance of the animals and decrease the deposition of fat in the carcass, which is not a desirable characteristic by the consumer.

Within the growth promoter group is ractopamine (RAC). Because it has the ability to active β-adrenergic receptors on the cell membrane, it is classified as a beta-adrenergic agonist, which belongs to the phenol-amine group (Squires et al., 1993). Therefore, it is considered a nutrient-splitting agent by redirecting them towards lean tissue deposition (Watkins et al., 1990).

Due to its characteristic of redirection of nutrients that would be used for lipid synthesis (Silveira et al., 2013), ractopamine inhibits the lipogenesis process, which at the same time favors the synthesis of proteins, not allowing the binding of insulin to the its receptor in the adipocytes, decreasing the production and accumulation of fat in the animals submitted to it, with a sense of greater deposition of lean tissue (Agostini, 2010), which impacts on productivity, improving the feed efficiency of the animals and providing lower values of fat on pork (Leal et al., 2014).

Therefore, the objective of this work was to evaluate the performance and carcass characteristics of high genetic potential barrows, supplemented with 0 or 10 ppm of ractopamine for 23 days pre-slaughter.

MATERIAL AND METHODS

Animal procedures were consistent with the Guide for the Care and Use of Animals in Agricultural Research and Teaching (FASS, 2010). The trial was conducted at the Experimental Center of Swine (CES) of the Department of Animal Science of the Federal University of Lavras, in Lavras (MG), from December 29, 2014 to January 20, 2015.

The seventy-two heaviest barrows from a group of 210 from a commercial line of high genetic potential were selected at 117 days of age. These pigs had a mean initial weight of 77.579 ± 8.621 kg. The pigs were housed in the finishing barn, composed of 24 pens, with dimensions of 1.70m x 1.80m per pen, with a semiautomatic feeder and a nipple drinker, where they remained for 23 days. The temperature was measured by a thermo-hygrometer and the average tempetature recorded was 26.6 ± 5 °C. Experimental design used was a randomized block with the initial weight used as a block factor, with two treatments (RAC - With addition of 10 ppm Ractopamine, Control - No addition of ractopamine) and twelve replicates, the experimental plot represented

by the composite pen with three animals.

Experimental diets (Table 1) were corn and soybean meal based, following the nutritional recommendations described in the Brazilian Poultry and Pig Tables (Rostagno et al., 2011). The experiment lasted for 23 days and the animals were fed ad libitum during the whole trial.

Table 1 – Ingredients and calculated centesimal composition of feed formulated for finishing pigs

Ingredients (%)	**Control**	**Ractopamine**
Corn	76.223	76.223
Soybean meal	19.889	19.889
Soybean oil	0.926	0.926
Dicalcium phosphate	0.765	0.765
Limestone	0.563	0.563
Salt	0.355	0.355
Vitamin premix[1]	0.250	0.250
Mineral premix[2]	0.300	0.300
DL-Methionine 99	0.090	0.090
L-Lysine 54,6	0.472	0.472
L-Threonine 98	0.099	0.099
Caolin	0.070	0.020
Ractopamine[4]	-	0.050
Total	100.00	100.00
Metabolizable energy, kcal/kg	3250	3250
Crude protein, %	15.00	15.00
Lysine (digestible), %	0.900	0.900
Methionine (digestible), %	0.306	0.306
Methionine + Cystine (digestible), %	0.458	0.458
Threonine (digestible), %	0.603	0.603
Calcium, %	0.474	0.474
Available phosphorus, %	0.231	0.231
Sodium, %	0.160	0.160

[1]Content per kg of product: Folic acid, 55 mg; Pantothenic acid, 2.500 mg; Biotin, 15 mg; Choline, 33 mg; Niacin, 5.00 mg; Selenium, 75 mg; Vitamin A, 1.000.000 UI; Vitamin B1, 180 mg; Vitamin B12, 360 mcg; Vitamin B2, 550 mg; Vitamin B6, 301 mg; Vitamin D3, 250.000 UI; Vitamin E, 5.600 UI; Vitamin K3, 550 mg; [2]Content per kg of product: Cobalt, 150 mg; Cooper, 70 g; Iron, 40 g; Iodine, 750 mg; Manganese, 25 g; Zinc, 60 g; [4]Ractopamine hydrochloride 2.05%.

Fonte: Elaborada pelo autor.

The pigs were weighed at the beginning of the experiment (117 days of age) and at the end (139 days of age) for determination of average daily gain (ADG). The feed provided and the wastage were weighed for the determination of the average daily feed intake (ADFI). Feed conversion (FC) was obtained through the relationship between ADFI and ADG. At the beginning of the trial (117 days of age) and at the end of the experiment (139 days of age), backfat thickness (BT), loin eye area (LEA) and loin depth (LD) were measured trough an ultrasound ALOKA model SSD-500 with a 3.5 MHz linear transducer model UST 5011. Measurements were made at 6.5 cm from the dorsal-lumbar line and 6.5 cm from the last rib in the cranial direction, at point P2. At the end of the experimental period, at 139 days of age the animals were sent to slaughter, in a slaughterhouse certified by the Federal Inspection System (SIF), located in the city of Lavras, MG. The carcass was weighed after slaughtering to determine the hot carcass weight (HCW), dressing percentage (DP) was calculated by the relation of HCW/final body weight. It was also evaluated carcass length (CL), weight-to-length ratio that is defined as carcass compactness (CC) and estimation of meat yield in the chilled carcass (MYCC) by the equation described by Guidoni (2000) where:

MYCC = 65.92 - (0.685 x BT) + (0.094 x LD) - (0.026 x HCW)

Where:
MYCC = meat yield in the chilled carcass (%);
BT = backfat thickness
LD = loin depth
HCW = hot carcass weight

The temperature and pH were measured on the Longissimus dorsi muscle of the left half carcass at the 12th rib height, 45 minutes after slaughter. These parameters were measured using the pHmeter Testo 205 (Testo do Brasil, Campinas - SP).

All variables measured were tested for normality by the Shapiro–Wilk test before analysis, and any variable that failed to follow a normal distribution was transformed through the RANK procedure of SAS (SAS Inst. Inc., Cary, NC). The PROC RANK statement with the NORMAL option was used to produce a normalized transformed variable. All data were analyzed using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC, USA) as a randomized complete block design (initial weight). For performance pen was considered as the experimental

unit. The effects of the treatments were compared by F test. All data are reported as least square means and the greatest standard errors (SEM) were reported. Results are considered significant if P < 0.05.

RESULTS

Results for initial body weight, average daily feed intake, average daily gain, feed conversion and final body weight and carcass characteristics. Final body weight and ADG were not affected by RAC. However, the animals that received RAC had a better (P =0.028) feed conversion of 8.5% and a lower (P =0.043) ADFI of 7.2% compared with animals from the control group.

Table 2 – Performance of barrows receiving or not ractopamine (10 ppm) from 117 to 139 days of age

VARIABLE	TREATMENT		CV (%)	*P*
	Control	RAC		
Initial weight, kg	77.48	77.68	5.10	0.682
ADFI[1], kg	3.05	2.83	8.21	0.043
ADG[2], kg	1.15	1.16	9.66	0.824
Feed conversion	2.68	2.45	9.14	0.028
Final weight, kg	102.77	102.39	4.37	0.827

Fonte: Elaborada pelo autor.

The data for back fat thickness, loin depth, loin eye are at 117, 139 days and after slaughter, hot carcass weight, dressing percentage, carcass length, carcass compactness, meat yield in chilled carcass, *Longissimus dorsi* muscle temperature and pH are presented in table 2. Ractopamine had no effect in all of these parameters.

Table 3 – Carcass characteristics of barrows in the finishing phase receiving or not ractopamine (10 ppm) from 117 to 139 days of age

VARIABLE	TREATMENT		CV (%)	*P*
	Control	RAC		
	117 days			
Back fat thickness, mm	3.97	4.03	36.35	0.420
Loin depth, mm	40.54	40.64	10.78	0.998
Loin eye area, mm	35.49	34.18	15.06	0.245
	139 days			
Back fat thickness, mm	35.49	34.18	31.54	0.245
Loin depth, mm	45.80	47.17	11.93	0.195
Loin eye area, mm	52.72	55.06	13.78	0.195
	After slaughter			
Hot carcass weight, kg	80.31	80.46	6.79	0.650
Dressing, %	78.22	78.28	1.28	0.976
Carcass length, cm	93.74	92.92	3.05	0.241
Carcass compactness	0.86	0.87	6.86	0.180
MYCC[3]	64.24	64.61	1.93	0.207
Temperature	40.61	40.66	1.41	0.894
pH	5.97	5.96	5.30	0.990

ADFI: Average daily feed intake ; [2]ADG: Average daily gain;
[3]MYCC: Meat yield in chilled carcass.
Fonte: Elaborada pelo autor.

DISCUSSION

Similar results were verified for ADG by Corassa et al. (2010) using 5 and 10 ppm of ractopamine in finishing pigs diet, researches verified no improvement in the weight gain of the animals, possibly no significant differences were observed for this variable as the animals in the group receiving RAC presented a lower feed intake, however, these animals maintained the same rate of weight gain, thus demonstrating their greater efficiency in nutrient utilization. Some authors verified better ADG, however most of them evaluated greater levels of RAC on the diet, Sanches et al. (2010) evaluating barrows receiving diets supplemented with 20 ppm of RAC verified that animals presented weight gain approximately 30% higher than those not supplemented, similar results were found by Cantarelli et al. (2009). As ADG were not different final weigh of the animals did not differ too, similar result found by Sanches et al. (2010) and Marçal et al. (2015) testing ractopamine levels in the diet. However, Garbossa et al. (2013) obtained a linear increase in the final weight of pigs receiving increasing levels of ractopamine (0, 5, 10, 15, and 20 ppm).

The animals supplemented with 10 ppm of RAC presented a reduction in consumption which possibility an improvement in the feed conversion, these results resemble again the study by Corassa et al. (2010), who verified lower feed intake by supplemented animals and improved feed conversion by 6.89%. Amaral et al. (2009) and Marçal et al. (2015) have shown that supplementation with 10 ppm of RAC can reduce daily feed intake.

This improvement in feed conversion was a result of

the decrease in feed consumption of ractopamine fed pigs, while maintaining similar weight gain between the two treatments. Considering the profitability, the improvement of the feed conversion is quite satisfactory since the animal produces the same amount with lower feed expenditure. The effect of ractopamine on the improvement of feed conversion has been reported by many authors (Marino et al., 2007). In the literature, the improvement in feed conversion is the performance variable that presents greater consistency in studies using ractopamine.

Food intake may be influenced by the hormone leptin, produced proportionally to the accumulation of adipose tissue (Havel, 2000). As the catabolic actions of adipose tissue are regulated by the sympathetic nervous system (Pénicaud et al., 2000), if there is activation of these innervations by the β-adrenergic agonists, there is an increase in the gene expression of leptin, in this way the reduction of the consumption of the animals, in the present study indicates that ractopamine may have increased the gene expression of leptin, yet the RAC may increase levels of NEFA and plasma glucose, which leads to stimulation of the satiety center.

Adverse responses with the use of RAC are observed in the literature due to the use of different genetic populations, inclusion levels and duration of the additive, as well as nutritional management (DUNSHEA et al., 1993; Smith et al., 1995). Another factor that may explain the results found in this experiment may be related to the superior genetic characteristics of the selected animals.

RAC supplementation had no effect over carcass characteristics, similar results were found by Philomeno (2012), studying the effect of ractopamine supplementation on finishing pig feed submitted to different thermal environments, found no difference (P> 0.05) for backfat thickness, loin depth, and area of loin eye. Barbosa et al. (2012) also did not observe a significant difference (P> 0.05) for the variables of meat yield in the cooled carcass and carcass dressing in animals supplemented with 0 or 10 ppm of RAC. In relation to the variables carcass weight, carcass length and carcass compactness, the results are similar to those found by Carvalho Junior (2014), who also did not observe a significant difference (P> 0.05).

RAC has been shown to influence on carcass characteristics (Carr et al., 2005; Weber et al., 2006), indicating that can increase muscle protein synthesis. Marçal et al. (2015) demonstrated superiority in the carcass characteristics of animals supplemented with ractopamine, but this was not observed in the present study, however generally these alterations are found in studies that use higher doses of RAC (20 ppm).

The results may have been influenced by the selection of heavier animals for this experiment and the relation between weight and age of pigs at slaughter. The animals were slaughtered at 139 days of age, with an average final weight of 102.58 ± 0.190 kg, indicating that they presented a growth curve with high potential for weight gain. They were not yet in the phase where the highest deposition occurred of adipose tissue where RAC has a more effective action. In addition, if animals fed diets containing ractopamine had received supplementation for longer than 23 days and were slaughtered heavier, the results for carcass traits could have been different.

CONCLUSION

The addition of 10 ppm of ractopamine in the diet of high genetic potential barrows during 23 days during the finishing phase is advantageous as improves feed conversion.

ACKOWLEGMENTS

To AnimalNutri, Ouro Fino Saúde Animal and to the members of the Study Group in Swine Production (NESUI) of the Federal University of Lavras for the support in the trial.

REFERÊNCIAS BIBLIOGRÁFICAS

BARBOSA, C. E. T. et al. Ractopamine in diets for finisshing pigs of different sexual categories. **Revista Brasileira de Zootecnia**, Viçosa, MG, v. 41, n. 5, p. 1173-1179, 2012.

CANTARELLI, V. S. et al. Características de carcaça e viabilidade econômica do uso de cloridrato de ractopamina para suínos em terminação com alimentação à vontade ou restrita.

Ciência Rural, Santa Maria, v. 39, n.3, p. 844-851, 2009.

CARR, S. N. et al. The effects of ractopamine hydrochloride on lean carcass yields and pork quality characteristics. **Journal of Animal Science**, Champaign, v. 83, n. 12, p. 2886-2893, 2005.

CARVALHO JUNIOR, F. M. **Utilização intermitente de ractopamina para suínos em crescimento e terminação**. 2014. 68 p. 2012. 116 p. Dissertação (Mestrado em Produção e Nutrição de Monogástricos) – Universidade Federal de Lavras, Lavras, 2014.

CORASSA, A.; LOPES, D. C.; TEIXEIRA, A. O. Desempenho características de carcaça e composição óssea de suínos alimentados com diferentes níveis de ractopamina e fitase. **Revista Brasileira de Zootecnia**, v. 39, p. 1740-1747, 2010.

DUNSHEA, F. R. et al. Interrelationships between sex and ractopamine on protein and lipid deposition in rapidly growing pigs. **Journal of Animal Science**, Champaing, v. 71, n. 11, p. 2919-2930, 1993.

FEDERATION OF ANIMAL SCIENCE SOCIETIES (FASS). 2010. **Guide for the care and use of agricultural animals in research and teaching**. 3rd ed. Champaign, IL:FASS (http://www.fass.org).

GARBOSSA, C. A. P. et al. Ractopamine levels on performace, carcass characteristics and quality of pig meat. **Revista Brasileira de Zootecnia**, Viçosa, MG, v. 42, n. 5, p. 325-333, 2013.

GUIDONI, A. L. melhorias de processos para a tipificação de valorização de carcaças suínas no Brasil. In: **ConFerência Internacional Virtual Sobre a Qualidade de Carne Suína**, 1., 2000. Anais... Concórdia: Embrapa, 200 p. 221-234.

HAVEL, P. J. Role of adipose tissue in body-weight regulation: mechanisms regulationing leptina production and energy balance. **Proceedings of the Nutrition Society**, Cambridge, v.59, p.359-371, 2000.

LEAL, R.S. et al. Qualidade da carne de suínos submetidos a dietas com diferentes níveis de ractopamina. **Revista Archivos de Zootecnia**. n. 63, v. 24, p. 507-518, 2014.

MARÇAL, D. A. et al. Ractopamina em dietas sem ajustes aminoacídicos para suínos machos castrados em terminação. **Revista Ceres**, v. 62, n. 3, 2015.

PÉNICAUD, L.; COUSIN, B.; LELOUP, C.; LORSIGNOL, A.; CASTEILLA, L. The autonomic nervous system, adipose tissue plasticity and energy balance. **Nutrition**, London, v.16, n.10, p.903-908, 2000.

ROSTAGNO, H. S. et al. **Tabelas brasileiras para aves e suínos: composição de alimentos e exigências nutricionais**. 3 ed. Viçosa, MG: UFV, 2011. 252 p.

SANCHES, J. F. Níveis de ractopamina para suínos machos castrados em terminação mantidos sob estresse por calor. **Revista Brasileira de Zootecnia**, v. 39, n. 7, p.1523-1529, 2010.

SAS INSTITUTE INC. **SAS user`s guide: statistics**. Cary, 2009. (Version 9.3) SAS Institute INC'.

SILVEIRA, C. O. et al. **Utilização de ractopamina na dieta de suínos**. In: V SIMPAC - Volume 5, 1, 2013, Viçosa. Anais... Viçosa, MG, 2013. p. 601-606.

SMITH, W. C. et al. Effects of ractopamine on the growth and carcass quality of entire male and female pigs fed ad libitum or at a restricted level. **New Zealand Journal of Agricultural Research**,Wellington, v. 38, n. 3, p. 373- 380, Sept. 1995.

SQUIRES, E. J.; ADEOLA, O.; YOUNG, L. G. The role of growth hormones, β-adrenergic agents and intact males in pork production: a review. **Canadian Journal of Animal Science,** Ottawa, v. 73, n. 1, p. 1-23, Jan. 1993.

USDA – UNITED STATES DEPARTMENT OF AGRICULTURE (2017). **Foreign Agricultural Service – Livestock and Poultry: World Market and Trade**. Disponível: em: < https://apps.fas.usda.gov/psdonline/circulars/livestock_poultry.pdf>. Acesso em: 05 de setembro de 2017.

WATKINS, L. E. et al. The effect of various levels of ractopamine hydrochloride on the performance and carcass characteristics of finishing swine. **Journal of Animal Science,** Champaign, v. 68, n. 11, p. 3588-3595, 1990.

WEBER, T. E.; RICHERT, B. T.; BELURY, M. A.; GU, Y.; ENRIGHT, K.; SCHINCKEL, A. P. Evaluation of the effects of dietary fat, conjugated linoleic acid, and ractopamine on growth performance, pork quality, and fatty acid profiles in genetically lean gilts. **Journal of Animal Science**, Champaign, v. 84, p. 720-732, 2006.