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Use of ractopamine during compensatory gain of finishing pigs on carcass and meat performance and quality

[*Uso de ractopamina durante ganho compensatório de suínos em terminação sobre o desempenho e a qualidade da carcaça e de carne*]

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ABSTRACT

The objective of this study was to evaluate the effects of compensatory gain associated with the use of 10ppm ractopamine after a period of feed restriction in finishing pigs on performance, carcass and meat quality. Twenty castrated males and 20 females, at 110 days of age and 66.137±6.13kg live weight, were submitted to four treatments using a 2 x 2 factorial design (fed *ad libitum* or with 20% restriction between 0–21 days of age and fed with or without 10ppm ractopamine for 22–42 days of experimentation), with 10 replicates (animals). There was no interaction between the factors for any of the evaluated parameters. Animals treated with ractopamine presented better weight gain (1.083 versus 1.259kg), feed conversion (2.910 versus 2.577), warm and cold carcass weight (86.08 versus 89.00 and 83.46 versus 87.20kg, respectively), loin depth (63.02 versus 68.40mm), loin eye area (41.43 versus 46.59mm^2) and muscle fiber diameter (27.48 versus 35.85µm). Animals submitted to feed restriction followed by *ad libitum* feed presented compensatory gain without losses to carcass and meat characteristics, but with a reduction in the ethereal extract (2.19 versus 1.64%) and lower water loss due to thawing in the meat (11.35 versus 9.42%). The effects of compensatory gain after food restriction and ractopamine are independent of the parameters evaluated.

Keywords: swine, beta-adrenergic, fat, food management, weight gain

RESUMO

Objetivou-se avaliar os efeitos do ganho compensatório associado ao uso de 10ppm de ractopamina após um período de restrição alimentar, em suínos em terminação, sobre características de desempenho, carcaça e qualidade de carne. Foram utilizados 20 machos castrados e 20 fêmeas, com 110 dias de idade e 66,137±6,13kg de peso vivo, submetidos a quatro tratamentos, fatorial 2 x 2 (alimentação à vontade ou com 20% de restrição entre zero e 21 dias de experimentação; e alimentação à vontade, sem ou com 10ppm de ractopamina, durante 22 a 42 dias de experimentação), com 10 repetições, sendo o animal a repetição. Não houve interação entre os fatores para nenhum dos parâmetros avaliados. Animais tratados com ractopamina apresentaram melhor ganho de peso (1,083 versus *1,259kg), conversão alimentar (2,910* versus *2,577), peso da carcaça quente e fria (86,08* versus *89,00 e 83,46* versus *87,20kg, respectivamente), profundidade do lombo (63,02* versus *68,40mm), área de olho de lombo (41,43* versus *46,59mm*^{2}*) e diâmetro de fibras musculares (27,48* versus *35,85µm). Animais submetidos à restrição alimentar seguida de arraçoamento* ad libitum *apresentaram ganho compensatório sem prejuízos às características de carcaça e à carne, mas com redução do extrato etéreo (2,19* versus *1,64%) e menor perda de água por descongelamento na carne (11,35* versus *9,42%) Os efeitos do ganho compensatório após a restrição alimentar e da ractopamina mostram-se independentes sobre os parâmetros avaliados.*

Palavras-chave: suíno, beta-adrenérgico, ganho de peso, gordura, manejo alimentar

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INTRODUCTION

In the growth and termination phases of swine herds, the considerable food expenditures have motivated the search for nutritional and management resources that optimize this situation. In this context, there are several classic procedures in the literature and even applied in practice that meet these principles including, among others, the food restriction followed by the compensatory gain (Purslow *et al*., 2012) and the use of ractopamine (Bridi *et al*., 2006; Agostini *et al*., 2011).

The ractopamine response depends on the dose used (Agostini *et al*. 2011) and dietary nutritional inputs, mainly crude protein and amino acids. However, studies on the association of ractopamine with compensatory gain are rather scarce and relatively old. Evaluating the effects of ractopamine supplementation (0, 5, 12.5 and 20ppm) under two food programs (*ad libitum* and under 13% food restriction), Smith *et al*. (1995) observed that there was only a linear improvement in weight gain and feed conversion as a function of the ractopamine levels used, with no associated effects of the procedures.

Mitchell (2009) evaluated the effects of ractopamine on growth and body composition of pigs during compensatory growth and found that pigs responded positively to treatment with ractopamine, resulting in an increase in lean tissue deposition and a decreased fat deposition during further growth.

Recognizing the effects of compensatory consumption after periods of food restriction, as well as the effects of ractopamine, the objective of this study was to increase the performance and carcass indices and to verify the possible repercussions on the meat quality by the simultaneous use of these resources. The hypothesis was that under superior ration intake, due to the compensatory consumption, the ractopamine present in the ration would find a higher level of substrates to increase its action.

MATERIAL AND METHODS

The present study was submitted and approved by the Commission on Ethics for the Use of Animals, the State University of Londrina (CEUA/UEL), Paraná, Brazil, under CEUA process number 24998.2014.16.

Twenty castrated males and 20 females at 110 days of age and 66.137±6.13kg live weight were submitted to the following four treatments: T1 - fed *ad libitum* between 0–21 days and a ractopamine-free ration between 22–42 days; T2 - fed *ad libitum* between 0–21 days and a ration containing 10ppm ractopamine between 22–42 days; T3 - 20% feed restriction between 0–21 days and a ractopamine-free ration between 22–42 days; and T4 - 20% food restriction between 0–21 days and a ration containing 10ppm ractopamine between 22–42 days. The feed consumption of animals fed *ad libitum* was computed daily and was used to calculate the 20% limitation of the consumption by animals that received the feed restriction. The experiment was arranged in a randomized block design in a 2 x 2 factorial scheme (with and without restriction, and with and without ractopamine) with 10 replicates. Each bay containing one animal represented one experimental unit.

The isonutritive rations (Table 1) were formulated to meet the minimum nutritional requirements predicted by Rostagno *et al*. (2011) for finishing pigs, except for the lysine level in the second experimental phase, where was followed the orientation of Mitchell *et al*. (1991). After deducting leftovers and losses, the animals and the consumed rations were weighed at the end of the phases, and the daily feed intake, daily weight gain and feed conversion were calculated. Blood was collected in Vacutainer flasks without anticoagulant, 7 days before the afternoon slaughter and the plasma urea levels measured on an Airone 200 automatic analyzer using the ultraviolet kinetic method and the Gold Analyzes kit.
At 152 days of age, the animals were slaughtered by electrocution using a Petrovina Ò IS 2000 equipped with two electrodes (350 volts and 1.3 amps), applied for approximately 3 seconds, with subsequent bleeding of the large vessels of the neck. After slaughter, the carcasses were divided in half lengthwise and cooled to 2±1ºC, for 24 hours, in a cooling chamber. The pH of the meat was measured in the *Longissimus thoracis* muscle at the last rib, using a Sentron 1001 potentiometer, at 45 minutes post-slaughter (initial pH) and at 24 hours after cooling (final pH) at 2±1°C.

Table1. Percentage and calculated composition of the experimental rations during the finishing phase

Ingredients	Finishing phase I	Finishing phase II without Ractopamine	Finishing phase II with Ractopamine
Corn grain (7,8%CP)	73.632	64.410	64.410
Soybean meal (45,5CP)	20.655	30.523	30.523
Soybean oil	2.79	2.217	2.217
L-lysine (HCl 79%)	0.176	0.076	0.076
Dl-methionine (99%)	0.021	0.010	0.010
Limestone (37%)	0.826	0.776	0.776
Dicalcium Phosphate (18%)	1.269	1.309	1.309
Salt	0.431	0.429	0.429
Vitamine supplement*	0.100	0.100	0.100
MIneral supplment**	0.100	0.100	0.100
Ractopamine (2%)	-	-	0.050
Inert	-	0.050	-
Total	100.00	100.00	100.00
Calculated values			
Metabolizable Energy (kcal)	3351.00	3400.00	3400.00
Crude Protein (%)	15.324	19.000	19.000
Ethereal extract (%)	5.816	4.609	4.609
Lysine total (%)	0.884	1.058	1.058
Methionine+Cysteine total (%)	0.529	0.630	0.630
Methioninetotal (%)	0.263	0.310	0.310
Threonine total (%)	0.603	0.723	0.723
Thryptophane total (%)	0.174	0.216	0.216
Calcium (%)	0.700	0.700	0.700
Phosphorus total (%)	0.521	0.563	0.563

*Levels of vitamin supplement per kg of product: Vitamin, A (min,) 16,000,000UI/kg; VitaminD3 (min,) 3,600,000UI/kg; Vitamin E (min,) 60,000UI/kg; Vitamin K3 (min,) 5,000mg/kg; Vitamin B1 (min,) 4,,000mg/kg; Vitamin B2 (min,) 11g/kg; Vitamin B6 (min,) 5,000mg/kg; Vitamin B12 (min,) 60,000mcg/kg; Niacin (min,) 44g/kg; Panthotenic acid (min,) 40g/kg; Folic acid (min,) 1,200mg/kg; Biotine (min,) 200mg/kg; Selenium (min,) 600mg/kg
**Levels of mineral supplement per kg of product: Manganese (min,) 25g/kg; Zinc (min,) 55k/kg; Iron (min,) 40g/kg; Copper (min,) 7,000mg/kg; Iodine (min,) 800mg/kg,

The carcass length (CC), backfat thickness (ET), *L. thoracis* muscle depth (PM), loin eye area (AOL), warm carcass weight (PCQ), cold carcass weight and carcass yield (RC), were measured according to the guidelines of Bridi and Silva (2009). From the ET and PM values, the lean meat yield (RCC) and the amount of meat (QCC) in the carcass were estimated, according to the method established by Guidoni (2000), where RCC (%) = 60 (ET x 0.58) + (PM x 0.10) and QCC (%) = (PCQ x RC).

At 24 hours post-slaughter, *L. thoracis* muscle samples were taken from the left half carcasses, from the height of the last rib towards the cranial portion of the animal. Samples were identified and stored at -18°C and subsamples of this muscle (steaks approximately 3cm thick), respecting the sequence of the cuts, were used for subsequent evaluations.

The water retention capacity of the meat was evaluated, considering water losses by dripping (Boccard *et al*., 1981), thawing and cooking.

The color of the *L. thoracis* muscle was analyzed 24 hours post-slaughter using a Minolta CR10 portable colorimeter, with integrating sphere and angle of view of 8º (i.e. lighting d/8 and illuminant C). The components L* (luminosity), a* (red-green component) and b* (yellow-blue component) were expressed in the CIELAB color system. The saturation index (C*) and the hue angle (h*) were evaluated according to the guidelines of Ramos and Gomide (2007).

The subjective evaluation of the degree of marbling was done using photographic patterns (Meat…, 2001) and assigning grades from 1 to 5 (1= marbling traces and 5= abundant marbling).

The evaluation of meat tenderness was performed at 1 and 7 days post-slaughter. Briefly, the meat samples were pre-cooked in a water bath pre-heated to 85°C, until reaching an internal temperature of approximately 78°C. After cooking, the samples were stored for 24 hours at 2±2˚C. Then, sub-samples of 2cm width x 1cm thickness x 1cm length were placed on a Stable Micro Systems TA-XT2i texturometer equipped with the Warner-Bratzler blade and the shear force measured perpendicular to the orientation of the muscle fibers (Bouton *et al.*, 1971). The myofibrillar fragmentation index was determined using the method described by Ramos and Gomide (2007).

For muscle cell diameter measurements, samples of the *L. thoracis* muscle were dissected and stored for 24 hours in Bouin’s solution, preserved in 70% alcohol and stained with hematoxylin and eosin. A Samsung SDC-415 digital camera and a Motic BA 300 microscope were used to capture images and the Images Plus 2.0ML program was used to determine the diameter of the muscle cells. Six microscopic fields were sampled randomly from each cut. The lowest diameter of 15 randomly selected muscle cells was measured, according to Dubowitz and Brooke (1973), totaling 90 observations per slide.

The data were analyzed in a factorial scheme and submitted to analysis of variance. For the variables that did not present an interaction effect, the F test was performed, using the SAEG statistical program (Sistema…, 1997).

RESULTS AND DISCUSSION

No interaction effect was observed between the food restriction and respective ractopamine factors for all analyzed characteristics. The results of zootechnical performance and plasma urea level at 35 days of evaluation are shown in Table 2.

Table 2. Effects of compensatory weight gain and ractopamine over the initial weight (IW), daily feed intake (DFI), daily weight gain (DWG), feed conversion rate (FCR), final weight (FW) and plasmatic urea (PU)

Parameters	Restriction		Ractopamine		P-value		VC (%)
	Without	With	Without	With	Restriction	Ractopamine	
IW (kg)	66.06	66.22	66.28	65.99	0.527	0.730	6.13
DFI (kg)	3.285	3.381	3.113	3.177	0.011	0.542	11.65
DWG (kg)	1.194	1.148	1.083	1.259	0.203	<0.001	12.62
FCR	2.796	2.691	2.910	2.577	0.305	0.002	12.76
FW (kg)	116.41	114.46	111.79	118.88	0.312	<0.001	7.14
PU(mg/DL)	43.67	33.97	38.09	39.77	0.179	0.732	56.07

*P: significant value for each factor

Based on these data, the results contradicted the expected hypothesis of a possible synergy between the *ad libitum* feeding phase, after the restriction period, associated with the use of ractopamine. According to Purslow *et al*. (2012), after a period of food restriction, there is a pronounced increase in the consumption of feed or nutrients when feeding *ad libitum*. Considering that ractopamine is substrate dependent, a higher dietary substrate value could lead to an increase in performance indices favored by the additive action.

Regarding the effects of the treatments alone, the animals receiving *ad libitum* feed after the feed restriction presented higher daily feed intake ($P<0.05$), proving the existence of compensatory consumption. These results agreed with those obtained by Martinez-Ramirez *et al*. (2008), who observed a similar effect in growing pigs after a period of nutrient intake restriction. The daily weight gain and feed conversion were similar to the group that received no restriction, characterizing the full recovery of the animals after the food limitation phase and validating the procedure. Similar observations were documented by Pacheco *et al*. (2007), after imposing a 20% feed restriction on animals in the same weight range.

For animals receiving ractopamine (Table 2), we observed advantages in daily weight gain, feed conversion and final weight (P<0.05), confirming the results commonly found in experiments using this beta-adrenergic agonist (Agostini *et al*., 2011).

For the plasma urea value (Table 2), there was a large variation in the responses (high coefficient of variation). Although this parameter indicates the status of nitrogen retention in the organism and that used for lean meat deposition, this hypothesis was not confirmed in the current study.

For the carcass traits (Table 3), no differences were observed in the parameters between animals that that were submitted to the food restriction and those who received continuous feeding *ad libitum* (P>0.05), indicating that the compensatory gain was effective for these characteristics, leading to the complete restoration of the animals. Considering the treatments with and without ractopamine, positive effects (P<0.05) were observed for ractopamine-treated animals on the variables of hot and cooled carcass weight, loin eye area and *L. thoracis* muscle depth.

Table 3. Effects of compensatory weight gain and ractopamine over the carcass traits

Parameters	Restriction		Ractopamine		P-value		VC (%)
	Without	With	Without	With	Restriction	Ractopamine	
HCW (Kg)	89.11	86.67	86.08	89.70	0.146	0.034	7.40
CCW (Kg)	86.62	84.04	83.46	87.20	0.122	0.028	7.58
LA (mm^2)	45.35	42.67	41.43	46.59	0.212	0.020	16.18
CY (%)	77.02	76.34	76.38	76.98	0.241	0.297	2.32
LMD (mm)	67.39	64.03	63.02	68.40	0.177	0.034	12.52
BT (mm)	14.85	14.05	14.99	14.90	0.912	0.956	33.30
PMW (%)	51.66	51.78	51.89	51.55	0.909	0.745	6.01
DL(%)	2.79	3.04	3.04	2.79	0.328	0.318	27.31

*P: significant value for each factor; HCW: hot carcass weight; CCW: cold carcass weight; LA: loin area; CY: carcass yield; LMD: *Longissimus dorsi* muscle depth; BT: backfat thickness; LA: loin area; PMW: percentage of lean meat, DL: drip loss

The results corroborate those found by Pacheco *et al*. (2007) and Briganó *et al*. (2008), who evaluated a 20% food restriction during 21 days, with subsequent feeding *ad libitum* until slaughter, in groups of animals that initiated the restriction at 30, 50 and 70kg live weight. In both of these previous studies, all animals submitted to the restriction presented compensatory weight gain, reaching similar values in the carcass parameters.

Considering treatments with and without ractopamine on carcass characteristics, the results validate the best effects obtained in the performance, confirming the role of ractopamine as an enhancer of the carcass characteristics (Agostini *et al*., 2011; Campos *et al*., 2013).

The effects of ractopamine factor (P<0.05) on dry matter and meat protein content were observed in the treated animals (Table 4). At day 1 post-slaughter, a higher fiber diameter and worse meat tenderness were observed for the animals that received the additive. Considering the restriction factor, the ethereal extract content and the loss of water in the thawing were significantly lower for those submitted to food restriction.

Table 4. Effects of compensatory weight gain and ractopamine over the centesimal composition of *Longissimus thoracis,* shear force, water loss due thawing, water loss due cooking, shear force, muscle fiber diameter and muscular fragmentation index

Parameters	Restriction		Ractopamine		P-value		VC (%)
	Without	With	Without	With	Restriction	Ractopamine	
DM (%)	28.59	27.25	28.65	27.19	0.06	0.04	7.85
AS (%)	1.15	1.13	1.15	1.13	0.40	0.20	8.12
EE (%)	2.19	1.64	2.10	1.72	0.01	0.07	33.89
CP (%)	24.02	23.90	24.67	23.25	0.83	0.02	7.964
WLT (%)	11.35	9.42	10.71	10.07	0.05	0.52	30.10
WLC (%)	21.77	23.02	21.77	23.02	0.58	0.89	33.60
SF1 (kg)	4.54	4.53	4.22	4.86	0.95	0.03	20.61
SF2 (kg)	3.78	4.43	4.20	4.02	0.07	0.63	27.21
MFD (µm)	31.55	31.78	27.48	35.85	0.87	0.00	14.14
MFI	76.45	76.68	75.04	78.09	0.88	0.06	6.71

*P: significant value for each factor; DM: dry matter; AS: ash, EE: ethereal extract; CP: crude protein; WLT: water loss due thawing; WLC: water loss due cooking; SF1: shear force at 1 ay; SF2: shear force at 7 day; MFD: muscle fiber diameter; MFI: muscular fragmentation index; VC (%) = variation coefficient.

Considering the treatments alone, animals receiving ractopamine had a lower percentage of dry matter in the muscle ($P<0.04$), indicating a higher retention of water in this tissue. This result confirmed the information obtained by Bridi *et al*. (2006), who also used the same dose of ractopamine for finishing pigs. Another effect associated with this higher retention of water and the reduction of ethereal extract in the meat ($P<0.07$) was the percentage of crude protein in this tissue ($P<0.02$), which presented a lower result for the ractopamine-treated groups. One of the principles of action of this additive is an increase in muscle mass, which is accompanied by greater water retention and fat reduction (mainly subcutaneous), justifying the observed results (Almeida *et al*., 2010; Rossi *et al*., 2010; Agostini *et al*., 2011). Rossi *et al*. (2010) treated castrated male pigs and finishing females with ractopamine rations (0, 10 and 20ppm) and verified that the use of the additive increased the moisture concentrations in the *L. thoracis* muscle and decreased the amount of fat in the meat.

For the groups submitted or not to food restriction management, the only significant result found in the bromatological analysis was for the ethereal extract (Table 4), where the animals submitted to the 20% feed restriction for 21 days, followed by feeding *ad libitum*, showed lower percentage of fat ($P<0.01$) in the meat. This result may be due directly to the loss of muscle fat during the restriction followed by an incomplete replacement of this tissue when returning to the *ad libitum* feeding. However, it may also be attributed to the difference in the deposition of the muscular tissue, which is considered larger for the group that was restricted and presented compensatory gain, due to increases in muscle protein turnover, with an advantage for protein synthesis over its degradation (Kristensen *et al*., 2002).

Regarding the parameters of water loss in thawing and cooking (Table 4), only a tendency of higher retention was observed for the group that received the food restriction and, later, the food *ad libitum* (consumption and compensatory gain). This result supports the findings of Pacheco *et al*. (2007), who used the same food restriction range (20% voluntary consumption) for final fattening pigs.

For animals treated or not with ractopamine, the absence of differences between the groups for some bromatological parameters and loss of water in the meat reiterates the findings of Bridi *et al*. (2006), who worked with 10ppm ractopamine. However, there are still divergences for this last parameter when ractopamine is used.

For the parameters of softness (Table 4), there was a worsening ($P<0.03$) for the shear force at day 1 post-slaughter for ractopamine-treated animals and a tendency of lower softness for the group submitted to food restriction with subsequent compensatory gain. The use of ractopamine on this attribute may be a result of increased muscle fiber diameter or reduced activity of the proteolytic enzyme calpain, whose decline is associated with a higher percentage of lean tissue. The action of beta-adrenergic agonists may stimulate calpastatin, an enzyme responsible for the inhibition of calpain. This enzyme also has a direct influence on the shear force and meatiness (Rubensam and Monteiro, 2000) because it is linked to the post-mortem degradation of the myofibrillar proteins, and therefore, to these meat quality parameters.

For the muscle fiber diameter (Table 4), there was a significant effect in favor of animals receiving ractopamine. This is a typical effect because the additive has outstanding actions in hypertrophic muscle enlargement (Bridi *et al*., 2006; Agostini *et al*., 2011).

For the muscle fragmentation index (Table 4), for both animals submitted to restriction management and those treated with or not treated with ractopamine, there was no difference between the treatments and all the meats presented a high index (the maximum value is 100), which indicates that all the meats had a high softness. The trend of increased softness for animals treated with ractopamine ($P<0.07$), however, contrasts with some previous studies (Rubensam and Monteiro, 2000; Carr *et al*., 2005).

The mean values of pH, color index and marbling (Table 5) only showed effects for the ractopamine factor, with the lowest averages for the initial pH value and the a* color index for the animals treated with this additive.

Table 5. Effects of compensatory weight gain and ractopamine over the initial pH, final pH and luminosity (L*) and color (a*, b* Chroma), tonality and marbling of pig meat

Parameters	Restriction		Ractopamine		P-value		VC (%)
	Without	With	Without	With	Restriction	Ractopamine	
Initial pH	6.22	6.22	6.27	6.17	0.896	0.045	4.35
Final pH	5.54	5.54	5.49	5.59	0.605	0.232	2.78
L*(mean)	52.18	52.21	52.63	51.75	0.981	0.480	42.81
a*(mean)	3.42	3.09	3.64	2.79	0.518	0.034	7.00
b*(mean)	11.36	10.95	11.53	10.78	0.358	0.102	39.45
Chroma	11.88	11.42	12.13	11.17	0.379	0.071	12.71
Tonality	1.292	1.303	1.270	1.325	0.652	0.039	14.08
Marbling	2.15	2.00	1.90	2.25	0.909	0.745	6.46

P: significant value for each factor; L (luminosity), a* (red-green component) and b* (yellow-blue component)

For the animals treated with ractopamine, the initial pH value was lower than the group exempt from this treatment. This result corresponds to the tendency that pigs treated with the drug, due to the consumption of muscle glycogen by the beta-adrenergic action of this additive, would have a lower production and accumulation of lactic acid in the carcass and increase in the final pH of the carcass (Wood *et al*., 1994). For the final pH, some studies do not indicate a change in this parameter when working with ractopamine levels between 0 - 20ppm (Almeida *et al*., 2010; Agostini *et al*., 2011).

For the color parameters (Table 5), there was only one effect for the a* index, where animals treated with ractopamine presented lower values than those that did not receive the additive. The use of ractopamine has been associated with a reduction in the values of a* and b* (Almeida *et al*., 2010; Agostini *et al*., 2011). In the present study, ractopamine may have lowered the presence of muscle oxymyoglobin (the pigment that gives meat its red color).

The absence of a difference in the b* (intensity of yellow) value, indicates that treatments with or without ractopamine or with or without restriction did not influence the variable (Table 5). The b* value (blue-yellow) of meat is generally associated with the presence of carotenoid pigments that deposit in the fat. This value can be altered when heavier animals are slaughtered (Cisneros *et al*., 1996) or when there is a change in the fatty acid composition of the meat (Joo *et al*., 2002), aspects not related to the treatments in this work.

Regarding the L* (luminosity) values, no differences were observed for animals that received ractopamine ration or not. Some studies support this result, pointing out that generally, luminosity is not influenced by the action of this additive (Bridgestone *et al*., 2006; Almeida *et al*., 2010; Agostini *et al*., 2011).

The absence of differences for the treatments related or not to the restriction and the compensatory gain for the color parameters are in agreement with Pacheco *et al*. (2007). Furthermore, they prove that it is possible to have a complete restoration of the parameters, also qualitative of meat, for animals that previously underwent a restriction process and then received feed *ad libitum*.

The marbling results (Table 5) also did not differ between animals submitted or not to the restriction. Again, this parameter confirms the muscle tissue recovery (Pacheco *et al*., 2007). Regarding the role of ractopamine for the marbling index, there was also no difference between the treatments. However, some studies have shown that the use of ractopamine at 10 and 20ppm, may result in decreased marbling, without influencing the quality of the meat to the consumer compared to control samples (no ractopamine) (Agostini *et al*., 2011). Conversely, supplementation of 5–7.4mg/kg ractopamine for animals slaughtered at high weight (133kg final weight) does not seem to influence marbling or consumer preference for the loin (*L. thoracis*) (Fernández-Dueñas *et al*. 2008).

CONCLUSION

Growth and finishing animals submitted to 20% food restriction voluntary consumption for 21 days, and fed *ad libitum* for the same period, presented compensatory gain without impairment of performance, carcass and meat quality characteristics. The effects of ractopamine and compensatory gain are independent and positive for both performance and carcass traits, as well as some characteristics associated with meat quality.

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