Effect of Ractopamine Hydrochloride on Growth and Carcass Characteristics of Lightweight Swine

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ABSTRACT

This study was conducted by using 65 pigs to measure the effects of feeding ractopamine hydrochloride (RAC) on growth and carcass characteristics of lightweight swine. Beginning weights averaged 68.23 kg. RAC was included in the diet at 0, 5, or 10 ppm for 25 days until an average end weight of 92 kg was achieved. Loin eye area, trimness (backfat measurements), and pork muscle quality factors of carcasses were evaluated 24 hours post-harvest at a commercial processing facility by trained personnel. No differences ($P>0.05$) were found between treatment groups for average daily gain (ADG) or feed:gain ratio. Groups fed 5 ppm RAC had lower weight loss from drift ($P<0.05$). No differences ($P>0.05$) between treatment groups were found for dressing percent, carcass length, first rib fat thickness, tenth rib fat thickness, or loin eye area. Last rib fat thickness and last lumbar fat thickness were significantly lower ($P<0.05$) for the two groups fed RAC. Firmness, color, and marbling were not affected by treatment group ($P>0.05$). These results suggest that feeding RAC to lightweight swine can reduce last rib fat while not impacting growth or other carcass traits.

KEY WORDS: Ractopamine, pork, carcass traits, growth, fat thickness, muscling

INTRODUCTION

Pork is the most widely consumed meat in the world. Of total worldwide meat consumption, pork stands at 40%. The next closest competitors are chicken at 29% and beef at 24% (USDA 2008). Although the swine industry has experienced a down-turn in the market at times because of rising feed costs and the H1N1 flu outbreak, it is still one of the major proteins supplied by the United States agricultural industry.

Most hogs in North America are marketed at 100–127 kg. However, some Asian markets in the United States require a smaller, lighter weight carcass of 86–95 kg possessing less than 1.27cm of backfat at the last rib. To enhance this market, it would be imperative to produce lightweight, lean pigs without a negative impact on pork muscle quality. The use of growth promotants such as RAC, could allow an increased number of swine to be marketed within these specifications. Research evaluating RAC inclusion in diets fed to light-weight pigs could provide valuable knowledge to producers interested in this market.

Phenethanolamines, commonly called beta-adrenergic agonists (β-agonists) or repartitioning agents, are compounds that alter the ratio which dietary energy intake is partitioned between lean and fat tissue, resulting in a positive shift in the lean:fat ratio of growing animals (Ricks et al., 1984; and Baker et al., 1984). These are small compounds which are structural analogues of naturally occurring catecholamines such as adrenaline (epinephrine) and nor-epinephrine (Buttery and Sweet 1993). β-agonists are adrenergic agonists that act on the beta-receptor sites in an animal's body to initiate several proteins into action which results in enzyme phosphorylation. The enzyme phosphorolation cascade is important in several metabolic processes (i.e., protein accretion, lipolysis, and etc.).

Experiments in this area could help researchers to understand the physiological effects of repartitioning agents on lightweight swine so that better management practices can be implemented to achieve maximum production efficiency. Thus, the purpose of this study was to compare the effects on growth rate and carcass characteristics of lightweight (86-95 kg) hogs supplemented with two levels of RAC versus those fed a control ration.

MATERIALS AND METHODS

Experimental Design.[1] Sixty five pigs were observed for the effect of RAC on growth and carcass characteristics of lightweight swine. The products used were MoorMan's 11256AB (RAC 9g/ton) and 277AB (No RAC). Both were manufactured by Elanco in Indianapolis, IN. All feeding was conducted at the Tarleton State University Swine Center in Stephenville, Texas and all harvest procedures were conducted at Columbia Packing Company in Dallas, Texas. The experimental design of this trial was a randomized complete block with initial pig weight as the blocking factor. Each pen of pigs served as an experimental unit. Pigs were assigned to pens within a weight block to achieve an even representation on the basis of weight, breed-type, and gender. Treatments were assigned randomly to the pens of pigs within a block.

Feeding and Growth Performance. Weights were recorded throughout the study to monitor growth rates (Rice Lake Weighing Systems, Rice Lake, WI; IQ Plus® 390-DC/590-DC Digital Weight Indicator / Paul Scale, W-W Manufacturing Thomas, OK; Model 58SX Hog and Sheep Crate Scale). Weights taken at the beginning of the experiment served as initial weights. The trial began when the average pen weight reached 59 kg. Prior to the start of the study, pens and feeders were steam cleaned and sanitized in order to provide a healthy environment for the pigs. Animals were visually inspected to confirm that they were healthy and sound enough to participate in the study. Feed composition is represented in Table 1.

At this time, the acclimation period began by offering the pigs the basal ration consisting of 16% CP medicated pellets was administered until the groups attained an average pen weight of 68 kg. This ration served as the base ration fed to the control treatment (0 ppm RAC). Feeders were cleaned out thoroughly prior to administering the individual treatment feeds. Beginning at 68 (± 0.77) kg, pigs were administered one of

[1] Approval by University Animal Use Committee was not applicable.

the three dietary treatments: the six pens in group #1 continued to receive a ration of 16% CP medicated pellets (0 ppm RAC;control). The six pens in group #2 were fed a ration of 16% CP medicated pellets with the inclusion of 5 ppm of RAC (5ppm RAC). The six pens in group #3 were fed a ration of 16% CP medicated pellets with the inclusion of 10 ppm of RAC (10ppm RAC). Groups were assigned to allow for uniform initial pen weight. All pigs were harvested when the average weight for the total group of pens reached 92 (± 1.33) kg in an average of 25 days. After all pigs were removed from the feeding pens, remaining feed was collected and weighed to adjust feed intake for feed:gain ratio calculations. All pigs were weighed immediately prior to loading at the Tarleton Swine Center and weighed immediately after unloading at the harvest location in order to measure drift weight. Travel time and distance to the harvest site was one hour and forty-five minutes and 167.4 kilometers, respectively. Animals were harvested in accordance with the packing plant's slaughter protocol and in compliance with the Humane Slaughter Act standards for humane slaughter.

Table 1. Experimental basal diet nutrient composition (as fed).

Item	Concentration
Crude Protein, %	16
Lysine, %	0.85
Crude Fat, %	4
Crude Fiber, %	5
Calcium (Ca), %	1.2
Phosphorus, %	0.6
Salt (NaCl), %	0.75
Selenium (Se). ppm	0.3
Zinc (Zn), ppm	475
Tylosin, g/ton	40

Carcass Characteristics. Twenty four hours post-harvest, carcass traits were measured by three trained personnel from Tarleton State University. Each person collected their data separate of the others and differences in data were resolved by all personnel conferring and agreeing on measurement. The left side of each carcass was ribbed between the tenth and eleventh ribs using a 63.5cm industrial meat hand saw (Northern Tool and Equipment, Burnsville, MN). Traits obtained were: hot carcass weight (HCW, kg), dressing percentage (DP), tenth rib fat depth (10RFD, cm), first rib fat depth (1RFD, cm), last rib fat depth (LRFD, cm), last lumbar vertebrae fat depth (LLFD, cm), loin eye area (LEA, cm^2), loin eye color, loin eye firmness, loin eye marbling, and carcass length (CL, cm). Measurement of fat thickness was taken using a swine backfat probe purchased from Nasco, Inc. (product number COO1HV) (Fort Atkinson, WI) and LEA was measured using a pork and lamb loin eye grid (Nasco, Inc). Carcass length was measured on the right side of the carcass, from the anterior edge of the aitch bone to the anterior edge of the first rib using a flexible plastic tape measure (Nasco, Inc.). Marbling scores range from 1 (devoid) to 9 (abundant). Color scores range from 1 (pale pinkish gray to white) to 6 (dark purplish red). Firmness scores range from 1 (very soft) to 5 (very firm). All quality characteristics (firmness, color, and marbling) were measured subjectively by the same three trained personnel from above using techniques specified in the NPPC Composition and Quality Assessment Procedures (NPPC 2000).

Statistical Analysis. Analysis was conducted by using the Statistical Analysis System. All data were analyzed linearly using the GLM procedure of SAS (Cary, NC) (Barr and Goodnight 1972). A *P* value of 0.05 was considered significant. Model terms included effect of three treatments: 0 ppm RAC, 5 ppm RAC, and 10 ppm RAC.

RESULTS AND DISCUSSION

Growth performance, leanness, and meat quality are some of the primary economically important traits to the pork industry. Utilizing feed additives to optimize growth rates and feed efficiency of hogs can increase profits for commercial swine feeding operations. Improved leanness will result in a higher premium at time of slaughter, when sold on a value based grid market. The combination of these improvements, while maintaining acceptable meat quality, is important to the pork industry.

Growth Performance. Growth performance data is presented in Table 2. Neither initial nor final body weights were different for any of the three treatment groups (P>0.05). This is consistent with reports by Fernandez-Duenas et al. (2008) and Patience et al. (2008). However, Armstrong et al. (2004) reported differences in ending weights among treatment groups. This result is explained by the increased days-on-feed and increased RAC inclusion rates employed in the fore mentioned study. Average daily gain and feed to gain ratios (F:G) were not different among treatment groups (P>0.05). These findings were contradictory to results from similar research presented by Xiao et al. (1999), Stroller et al. (2003), Armstrong et al. (2004), See et al. (2004), and Carr et al. (2005). Drift percentage tended to decrease (P<0.08) for the 5 ppm treatment group, but was not statistically different. This result is similar those reported by Carr et al. (2005), which found no difference in live shrinkage among treatment groups.

Carcass Measurements.

General. Carcass traits are presented in Table 3. Inclusion of RAC in the diet did not have an effect on HCW (P>0.05). This agrees with data presented in Watkins et al. (1990) and Uttaro et al. (1993). However, this finding is different from those of Carr et al. (2005), Fernandez-Duenas et al. (2008), and Kutzler et al. (2010), who found an increase in HCW as RAC level increased. Dressing percent was not different among treatment groups (P>0.05). This result is contrary to reports from Watkins et al. (1990), Carr et al. (2005), and Kutzler et al. (2010). Feeding of RAC failed to significantly alter carcass length (P>0.05) which agrees with the findings of Stites et al. (1991), Crome et al. (1996), See et al. (2004), and Carr et al. (2005), who indicated no significance among RAC fed treatment groups for CL with finishing swine. However, Watkins et al. (1990) and Yen et al. (1990) both reported shorter carcasses with the inclusion of RAC in finishing swine diets. The reduction in carcass length can be explained by more nutrients being devoted to protein accretion than to osteogenesis due to the chemical action of ractopamine. The effect of RAC on carcass length maybe more pronounced during the finishing phase than the growing phase. However, the results from the previous studies were reported during the finishing phase.

Table 2. Effect of ractopamine hydrochloride (RAC) on growth of lightweight swine.

Item	0 ppm RAC	5 ppm RAC	10 ppm RAC	SEM[d]	*P*-value
Initial BW, kg	68.59	68.37	67.72	0.77	0.72
Final BW, kg	93.36	90.74	91.98	1.33	0.4
ADG, kg[a]	0.99	0.88	0.96	0.06	0.41
Feed:Gain, kg[b]	2.75	2.84	2.52	0.21	0.56
Drift %[c]	3.05	2.49	3.07	0.19	0.08

Within a row, means with different superscripts differ ($P<0.05$).

[a] ADG (Average Daily Gain) was calculated by total weight gain per pig divided by the number of days on feed.

[b] Feed:Gain ratio was calculated by dividing total kg of feed intake (as-fed basis) divided by total kg of gain per pig.

[c] Drift Percentage (%) was calculated by dividing the live weight recorded at the packing plant by the weight recorded prior to leaving the TSU farm then multiplied by 100.

[d] Standard Error of the Mean.

Backfat. There was no difference among treatment groups for first rib fat thickness ($P>0.05$). In contrast, Crome et al. (1996) and Webster et al. (2002) reported decreases in first rib fat thickness for RAC treatment groups. No difference between treatment groups was found for tenth rib fat thickness ($P>0.05$). These findings are similar to those reported by Carr et al. (2005) and Kutzler et al. (2010). Contrarily, Watkins et al. (1990) and Fernandez-Duenas et al. (2008) found tenth rib fat thickness to be lower for those groups fed RAC. Last rib fat thicknesses were 2.18, 1.90, and 1.84 cm for the 0, 5, and 10 ppm treatments, respectively. Groups fed 5 and 10 ppm RAC were trimmer over the last rib ($P<0.01$) than those fed the 0 ppm RAC ration. This agrees with the findings of Williams et al. (1994) which reported lower last rib fat thicknesses for RAC fed groups. However, Weber et al. (2002) and Kutzler et al. (2010) found no differences in last rib fat thickness among RAC or control treatments. No differences were found among any treatments ($P>0.05$), which agrees with findings reported by Carr et al. (2005).

Muscling. There was no difference between groups for LEA ($P>0.05$). These findings were contrary to those of Stoller et al. (2003) and Carr et al. (2005). This inconsistency could be due to the earlier stage of growth and development for the hogs used in the present experiment as compared to older, heavier finishing swine used in previous research. During the growth phase in swine, muscle growth is somewhat rapid under normal nutritional regimes. A significant effect may not arise with the supplementation of RAC as it would during the finishing stage because muscle is being developed instead of fat during the growth stage. Within the finishing stage, muscle growth slows and adipose tissue begins to deposit more readily. The difference in physiological maturity for lightweight pigs used in the current study compared to older, more mature pigs used in finishing studies could explain the results.

Table 3. Effect of ractopamine hydrochloride (RAC) on carcass characteristics of lightweight swine.

Item	0 ppm RAC	5 ppm RAC	10 ppm RAC	SEM	*P*-value
HCW, kg	65.47	64.39	64.47	0.93	0.67
DP[a]	70.14	70.99	70.09	0.57	0.47
Carcass Length[b], cm	73.33	72.28	72.77	0.87	0.7
1st rib FT[d], cm	3.43	3.29	3.3	0.13	0.71
Last rib FT, cm	2.18[x]	1.90[y]	1.84[y]	0.07	0.01
Last Lumbar FT, cm	1.85	1.64	1.61	0.12	0.37
10th rib FT, cm	1.45	1.24	1.25	0.12	0.37
LEA[c], cm^2	45.13	44.65	45.96	1.67	0.86

[x,y] Within a row, means with different superscripts differ ($P<0.05$).
[a] Dressing Percentage (DP) was calculated by dividing the hot carcass weight (HCW) by the live weight multiplied by 100.
[b] Carcass length was measured from the anterior edge of the aitch bone to the anterior edge of the first rib.
[c] Loin eye area, as measured at the 10th rib.
[d] Fat Thickness (FT).

***Pork Quality*.** Pork Quality data is represented in Table 4. Color scores ranged from 1 (pale pinkish gray to white) to 6 (dark purplish red). There was no difference between color scores for the treatment groups ($P>0.05$). These results were consistent with the findings of Stoller et al. (2003), Carr et al. (2005), Fernandez-Duenas et al. (2008), and Kutzler et al. (2010). Since lean color was not negatively impacted by RAC, this observation would support the use of this additive for the commercial swine industry. Furthermore, fluctuations in muscle color are usually a sign of abnormal pH, which in-turn can result in poor consumer acceptance (De Vol et al., 1988).

Table 4. Effect of ractopamine hydrochloride (RAC) on pork quality characteristics of lightweight swine.

Item	0 ppm RAC	5 ppm RAC	10 ppm RAC	SEM	*P*-value
Color[a]	2.07	2.29	2.04	0.1	0.2
Marbling[b]	1.06	1.04	1.01	0.03	0.56
Firmness[c]	3.42	3.69	3.52	0.29	0.71

Within a row, means with different superscripts differ ($P<0.05$).
[a] NPPC color standards (NPPC, 1999).
[b] NPPC marbling standards (NPPC, 1999).
[c] NPPC firmness standards (NPPC, 1999).

Marbling in pork is not regarded in high priority as in beef, yet increased marbling typically has resulted in greater consumer palatability and satisfaction (Brewer et al., 2001). Marbling scores can range from 1 (devoid) to 9 (abundant). No difference between treatment groups was found for marbling score ($P>0.05$). High marbling scores were not expected for this experiment, due to the stage of growth and development of the swine utilized. These findings agreed with the results of Stoller et al. (2003), Carr et al. (2005), Fernandez-Duenas et al. (2008), and Kutzler et al. (2010), who found no change in marbling scores among groups fed RAC diets and the control groups in finishing swine.

Firmness scores can range from 1 (very soft) to 5 (very firm). No differences were found for firmness scores between treatments (P>0.05). This result was similar to that reported by Stoller et al. (2003), Carr et al. (2005), and Fernandez-Duenas et al. (2008). However, Kutzler et al. (2010) observed an increase in firmness scores due to inclusion of RAC in the diet, but these changes were described as 'minimal' by the authors. Any product that had a significant effect on pork quality would most likely not be adopted by the commercial swine industry, for fear of decreased consumer acceptance.

CONCLUSIONS

Feeding RAC in growing swine diets did not have an effect on growth or feed efficiency for swine from 68–92 kg of body weight. Carcass cutability factors were also unaffected by RAC with the exception of last rib fat thickness. Dressing percentage, carcass length, first rib FT, last lumbar vertebrae FT, tenth rib FT, and LEA exhibited no differences among treatments. RAC inclusion in the diet had no effect on any of the pork muscle quality attributes measured in this study. Last rib fat thickness was lower for the two RAC-fed groups. Lower last rib fat thickness should result in higher premiums for producers. Results of this study suggest RAC can be fed in lightweight swine diets and achieve a decrease in last rib fat thickness while maintaining acceptable meat quality.

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