EFFECTS OF DIFFERENT LEVELS OF RACTOPAMINE, DIGESTIBLE LYSINE AND METABOLIZABLE ENERGY ON PORK COMPOSITION AND TENDERNESS

Rubio, MS*[a], Velásquez-Madrazo, PA[b],Cuarón, JA[b], Balderas M[b], Barcía-Bautista, G[b], Castaño, A[c], López-Espinosa, JJ[c]
[a] Facultad de Medicina Veterinaria y Zootecnia, UNAM, Ciudad Universitaria, México 04510
[b]Centro Nacional de Investigación en Fisiología y Mejoramiento Animal, INIFAP
[c] ELANCO, División de Ely Lilly, México

Background

Ractopamine (RAC) has been approved in Mexico, United States and other countries of America and Asia. Previous research on RAC has studied its effects on carcass growth and evaluation of color, firmness and marbling. The majority of the information available is around a decade old (Uttaro et al., 1993; Spurlock et al., 1994), but RAC is currently used in commercial production.

Ractopamine is an effective repartitioning agent that promotes lean production (Tarrant, 1992) and mildly increases lipolysis in finishing pigs (Peterla and Scanse, 1990). The suggested mechanisms of action of RAC are that it increases the rate of skeletal muscle protein accretion in pigs (Mills, 2001), and that decreases the proteolytic activity both in the live animal and in the meat post-mortem (Tarrant, 1992). Both mechanisms could have an impact on meat quality, especially tenderness.

Even though, the toughening effects on meat are usually greater in ruminant than in pigs (Tarrant, 1992), it is important to rule out the effects when using RAC. It has been shown that beef or lamb treated with ß-adrenergic compounds is firmer and coarser due to an increase on the myofibrils diameter (Kim et al., 1987 y Crouse et al., 1991). Therefore it is important to know how it would affect pork quality.

Ractopamine stimulates triglyceride hydrolysis in vivo and in vitro. However, absolute rates of fat accretion are not consistently observed in feeding studies (Mills, 2001). These effects can also influence the quality of the meat because it could reduce the percentage of intramuscular fat turning the meat tougher (Savell and Cross, 1986).

Objective

The objective of this research was to study, in commercial stress conditions (respiratory diseases in an environment of daily temperatures above the thermo neutral zone) that may limit intramuscular fat synthesis, the effects of different combinations of RAC, metabolizable energy and lysine on the quality and composition of pork.

Methods

Pigs were progeny of a contemporary terminal cross and were housed in an open front facility, 26 pigs (13 gilts and 13 barrows) to a solid floor pen providing 1.72 m^2/pig, 6 nipple watering devices, 8 feeding spaces from a self-feeder and a 1.5x2x0.5m shallow pool (a means of self-cooling).

Three fortified Maize-Soybean meal-Canola meal diets were formulated: Control, being the normal farm finisher diet, with 13.5% Crude Protein (CP), 0.58% digestible Lysine (Lys) and 3.15 Mcal of Metabolizable Energy (ME)/kg; Low energy (3.15 Mcal of ME/kg) and corrected digestible Lys (0.92%, and 18.5% CP) and a High energy Control (3.30 Mcal of ME/kg), corrected digestible Lys (0.92%). In all cases an Ideal Protein pattern was kept. Treatments were: 1) Control; 2) Low energy corrected Lys, 5 ppm RAC; 3) High energy Control; 4) High energy diet, 5 ppm RAC and 5) High energy diet, 10 ppm RAC. At day 36, pigs were slaughtered. After 24 h refrigeration, four 2.5 cm thick chops were obtained from each loin for quality analysis. One chop was packaged on a plastic bag to measure drip loss.

Chemical analysis, protein, intramuscular fat and moisture percentages were analyzed using the methods proposed by AOAC (1990). To measure shear force (using Warner-Bratzler device), chops were cooked and cooking losses were measured (AMSA, 2000). Analysis of variance was used to statistically study the data, being treatment groups the class variable. When significant differences were found, a Lsmeans analysis was applied to separate the means.

Results

Ractopamine had no effect ($P>0.05$) on the meat ability to retain water, measured throughout drip loss (Table 1). This agrees with results found by McKeith and Ellis (2001). Ractopamine did not affect either the percent of moisture or protein in meat ($P>0.05$).

The effect on intramuscular fat was inconsistent: The three RAC treatments had numerically lower percentages of intramuscular fat. Treatments 2 and 5 (RAC at 5 or 10 ppm) were not different ($P>0.05$) from controls; although, it could be observed that there is a tendency to lower intramuscular fat in RAC fed animals, but the response seems to be diet dependent. McKeith and Ellis (2001) found no effect of RAC on marbling, although marbling is a subjective measure, which is not as accurate as the percentage of fat. Uttaro et al., (1993) found that carcasses from animals that had been treated with RAC showed 1.8 mm less of fat compared to those carcasses from control animals. It is known that ractopamine affects the energy flux to muscle, favoring protein synthesis; therefore, energy density of the diet and the effects on net energy by protein provision could alter energy availability for intramuscular deposition. Lower protein diets tend to increase intramuscular fat, and the opposite is true for amino acids excesses (Castañeda y Cuarón, 2001). Thus in meat quality, the effects of RAC need to be necessarily coupled to nutrient density and voluntary feed intake. This is relevant in the conditions animals were grown: stress and lower feed intake tend to reduce energy availability for muscle use and lower muscular protein synthesis.

Cooking loss results indicated that using 5 ppm of RAC would increase the cooking losses; however, 10 ppm of RAC had the same effects as the controls. Uttaro et al., (1993) using 20 ppm of RAC found that the cooking loss decreased compared to controls. Results from the shear force analyses showed minor differences between treatments, accounting with the fact that the concentration of RAC was not high, compared to others studies (Uttaro et al., 1993). The only significant difference ($P<0.05$) was found in Treatment 2 (lower energy, RAC at 5 ppm), which value was lower with respect to the other treatments. Uttaro et al., (1993) observed that a treatment with 20 ppm of RAC increased significantly the Warner Bratzler shear force values. McKeith and Ellis (2001) reported inconsistent results for shear force on meat from pigs treated with RAC. It is difficult to explain why other treatments including RAC did not show a similar response, but dietary interactions must be studied in detail, particularly on the effects of Net Energy.

Conclusions

Results from this study suggest that Ractopamine used in combinations with different levels of ME or Lys does not affect negatively pork composition and tenderness. However, results indicated that further studies are needed to better understand these interactions.

Pertinent Literature

AMSA. American Meat Science Association. Research Guidelines for cookery and sensory evaluation, instrumental tenderness measurements of fresh meat. 2000. Published by American Meat Science Association in cooperation with National Live Stock and Meat Board.

AOAC. Official Methods of Analysis. 15th edit. Association of Official Analytical Chemists. Virginia, USA 1990

Castañeda S EO, Cuarón I JA. 2001. Lysine to protein ratios in growing-finishing pigs. J Anim Sci. 2001. Jul. 79(Suppl. 1):321.

Crouse JD, Koohmaraie M and Seidman SC. 1991. The relationship of muscle fiber size to tenderness of beef. Meat Sci. 30:295.

Hedrick HB, Fennewald KJ, Bailey ME, Heyman H, Mawhinney TP, Chang CH and Wallace, DH. 1991. Effect of ß agonists on composition of pork longissimus muscle. Proc. International Congress Meat Science and Technology, Kulmbach, pp. 377-380.

McKeith FK and Ellis M. 2001. Effects of ractopamine on meat quality. J.Anim. Sci. Vol. 79, Supl 1. Pag 239.

Mills SE. 2001. Biological basis of the ractopamine response. J.Anim. Sci. Vol. 79, Supl 1. Pag 238.

Kim YS, Lee YB and Dalrymple RH. 1987. Effect of the repartitioning agent cimaterol on growth, carcass and skeletal muscle characteristics in lambs. J.Anim. Sci. 65:1392

Peterla TA and Scanes CG. 1990. Effect of beta-adrenergic agonists on lipolysis and lipogenesis by porcine adipose tissue in vitro. J. Anim. Sci. 1990. 68:1024

Savell JW and Cross HR. 1986. The role of fat in the palatability of beef, pork, and lamb. Meat Research Update, 1:4 (1986).

Spurlock ME, Cusumano JC, Ji SQ, Anderson DB, Smith CK 2nd, Hancock DL, Mills SE. 1994. The effect of ractopamine on beta-adrenoceptor density and affinity in porcine adipose and skeletal muscle tissue. J Anim Sci. 1994 Jan. 72(1):75-80.

Tarrant PV. 1992. Production factors affecting meat quality. In Pork Quality. Genetic and Metabolic Factors. Ed. E. Puolanne and D.I. Demeyer with M Ruusunen and S. Ellis. Wallingford, Oxon, UK.

Uttaro BE, Ball RO, Dick P, Rae W, Vessie G, Jeremiah LE. 1993. Effect of ractopamine and sex on growth, carcass characteristics, processing yield, and meat quality characteristics of crossbred swine. J Anim Sci. 1993 Sep. 71(9):2439-49.

Table 1. Compositional traits and tenderness of pork treated with Ractopamine under different feeding conditions.

Variable	%Drip Loss	%Moisture	%Protein	%Intramuscular fat	%Cooking loss	WB, kg
Trt 1, Low energy, control, 0.58% Lys	3.47±0.36	73.63±0.22	22.21±0.18	$2.15 \pm 0.12^{a,c}$	$24.12^{a,c} \pm 0.74$	$2.88^{a} \pm 0.06$
Trt 2, Low energy 5ppm RAC, 0.92% Lys	2.40±0.36	74.17±0.23	22.05±0.18	$1.85 \pm 0.12^{a,b}$	$26.63^{b} \pm 0.88$	$2.59^{b} \pm 0.07$
Trt 3, High energy, control, 0.92% Lys	2.71±0.36	73.79±0.22	22.32±0.18	2.34 ± 0.12^{c}	$23.44^{a,c} \pm 0.77$	$2.89^{a} \pm 0.06$
Trt 4, High energy, 5 ppm, 0.92% Lys	3.14±0.37	74.10±0.23	22.22±0.18	1.63 ± 0.12^{b}	$26.86^{b} \pm 0.85$	$2.85^{a} \pm 0.07$
Trt 5, High energy, 10 ppm, 0.92% Lys	2.65±0.38	73.95±0.23	22.70±0.18	$1.82 \pm 0.13^{a,b}$	$24.06^{c} \pm 0.77$	$3.02^{a} \pm 0.06$

^{a,b,c}Different superscripts within a column, stand for significant differences (P<0.05)