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INFLUENCE OF THE $-AGONIST, ZILPATEROL, ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF FEEDLOT STEERS

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ABSTRACT: One hundred forty crossbred steers (373 kg) were used in a randomized complete block design experiment (14 pens, 10 steers/pen) to evaluate the influence of supplementation of a steam-rolled wheat-based finishing diet with 6 mg/kg (as-fed basis) zilpaterol during the final 6 weeks of the finishing period on growth performance and carcass characteristics. Supplemental zilpaterol did not influence (P > .20) DM intake (8.55 vs 8.45 kg/d), but enhanced (P < .01) ADG (27%, 1.42 vs 1.94 kg/d), and feed efficiency (28%, 6.08 vs 4.37). Based on observed NE intake, ADG of the non-supplemented steers was 99% of expected. In contrast, with zilpaterol supplemented steers ADG was 29% greater (P < .01) then expected. Zilpaterol supplementation increased carcass weight (4.5%, P < .01), dressing percentage (3.6%, P < .01), and longissimus muscle area (2.7%, P < .10). But, did not influence (P > .20) KPH, fat thickness, or marbling score. Adjusting to a constant carcass weight, zilpaterol supplementation increased gross (bone- and trim-in) primal cuts (1.7%, P < .01), boneless closely trimmed primal cuts (2.9%, P < .05), and boneless closely trimmed retail cuts (3.2%, P < .10). We conclude that zilpaterol supplementation can have marked beneficial effect on growth performance and carcass yield of feedlot steers. Enhanced growth performance accounts for 55% of the net economic value of zilpaterol supplementation (benefit to the feeder), while increased carcass cutability accounts for 45% of the net value (benefit to the meat packer and retailer).

Introduction

Zilpaterol chlorhydrate is a catecholamine analog belonging to a family of compounds pharmacologically known as $-2-agonists. The $-agonists enhance growth efficiency by stimulation of $-adrenergic receptors on cell surfaces. In muscle tissue, $-agonists promote protein synthesis and cell hypertrophy by inhibition of proteolysis (rate of protein synthesis, per se, is not affected). In adipose tissue, $-agonists promote lipolysis. This redirecting of cellular energy metabolism in favor of protein synthesis has prompted the referencing of some $-agonists as “repartitioning agents” (Reeds and Messermann, 1991). The objective of this study was to evaluate the influence of zilpaterol supplementation during the last 42 d of the feeding period on growth performance and carcass characteristics of steers.

Experimental Procedure

One hundred and forty crossbreed yearlings steers (373 kg) were used in a 42-d finishing trial. Steers were blocked by weight and randomly assigned, within weight groupings, to 14 pens (10 steers/pen). Pens were 510 m^2 with 64 m^2 overhead shade, automatic waterers, and 17 m fence-line feed bunks. The trial was initiated July 22, 1997. Treatments consisted of a steam-flaked wheat-based finishing diet (Table 1) supplemented (as fed basis) with 0 or 6 mg/kg zilpaterol (Zilmax®, Hoechst Roussel Vet, D.F., Mexico). Steers were implanted with Revalor® (Hoechst Roussel Vet, D.F., Mexico) upon initiation of the trial. Steers were allowed ad libitum access to experimental diets. Fresh feed was added twice daily. Zilpaterol was withdrawn from the diet during the final 2 d of the trial. Hot carcass weights were obtained from all steers at time of slaughter. After the carcasses were chilled for 48 h the following measurements were obtained: 1) longissimus muscle area (ribeye area), taken by direct grid reading of the eye muscle at the twelfth rib; 2) subcutaneous fat over the eye muscle at the twelfth rib taken at a location 3/4 the lateral length from the chine bone end; 3) kidney, pelvic and heart fat (KPH) as a percentage of carcass weight and 4) marbling score (USDA, 1965). Yield of boneless, closely trimmed retail cuts from the round, loin, flank, rib, chuck, brisket and plate, as well as yields of subprimal cuts from tenderloin, knukle, inside round, gooseneck, heel, outside and inside skirt, back rib, short plate, triangle, chuck roll, chuck tender, flank steak, shank and neck were removed and weighed individually from forty-two carcass (three carcass/pen). In determining steer performance, initial and final weights were reduced 4% to account for digestive tract fill. Steer ADG (kg/d) was based on carcass adjusted final weights (carcass weight/.628, where .628 is the average dressing percentage of all 140 steers/100). Energy gain (**EG**) was calculated by the equation: $EG = (.0493BW^{.75})ADG^{1.097}$, where EG is the daily energy deposited (Mcal/d), ADG is live weight gain (kg/d) and BW is the mean body weight (kg; NRC, 1984). Maintenance energy expended (Mcal/d, EM) was calculated by the equation: $EM = .077BW^{.75}$ (Lofgreen and Garrett, 1968). The NE values of the diets for maintenance and gain were obtained by means of the quadratic formula $\left(x = \frac{-b \pm \sqrt{b^2 - 4}}{2c} \right)$, where a = -.41EM, b = .877EM + .41DMI + EG, c = -.877DMI, and $NE_g = .877NE_m - .41$. This trial was analyzed as a randomized complete block design experiment (Hicks, 1973). Pen means were used as experimental units. Treatments effects on yields of trimmed cuts were adjusted to a constant carcass weight by the inclusion of carcass weight as a covariate in the statistical model.

Results and Discussion

Treatment effects on growth-performance and dietary NE are shown in Table 2. Inclusion of zilpaterol in the diet did not effect DMI (P > .10) but enhanced ADG (36%, P < .01) , feed/gain (39%, P < .01), dietary Ne_m(23%,P < .01), and dietary En_g (29%,P<.01). Improved ADG and feed efficiency with no effect on DMI has been a consistent observation with $-agonist supplementation of finishing diets for feedlot cattle (Maltin et al., 1987; Schiaveta et al.,1990, Reeds and Messermann, 1991).

The degree to which the increase in dietary NE with zilpaterol supplementation was due to reduced maintenance energy expenditures (i.e. reduced protein turnover) and/or leaner tissue gain (lower then expected EG/kg live weight gain) cannot be determined from this study. However, for the practical purpose of estimating steer performance in feedlots where zilpaterol is being fed, the expected enhancement in energetics may be accounted for by either increasing dietary NE 26%, or decreasing the maintenance coefficient 59%.

The influence of zilpaterol on carcass characteristics is shown in Table 3. Zilpaterol increased carcass weight (4.8%, P < .10), dressing percentage (3.6%, P < .01), and longissimus area (2.7%, P < .10). There were no treatment effects (P > .10) on fat thickness, KPH, retail yield, marbling score, or liver abscess. Increased carcass weight, dressing percentage and longissimus area, with no effect on marbling score has been a consistent effect of $-agonists in feedlot cattle (Ricks et al., 1984; Schiavetta et al., 1990; Chikhou et al., 1993a,b). In some cases $-agonists have decreased fat thickness and KPH (Ricks et al., 1984; Chikhou et al., 1993a).

The influence of zilpaterol on yields of wholesale cuts as a percentage of carcass weight are shown in Table 4. Zilpaterol increased the percentage yield of boneless (P < .01) and bone-in (P < .05) sirloin. In contrast zilpaterol reduced the percentage of bone in round (P < .01), trimless brisket (P < .05), and bonless short loin (P < .05). Overall, zilpaterol supplementation increased gross (bone- and trim-in) primal cuts (1.7%, P < .01), boneless closely trimmed primal cuts (2.9%, P < .05) as a percentage of carcass weight.

The influence of zilpaterol on yields of subprimal cuts as a percentage of carcass weights in shown in Table 5. Zilpaterol increased percentages of knuckle (P < .01), inside skirt (P < .01), neck (P<.01), inside round (P < .05), and triangle (P < .05). Zilpaterol decreased (P < .01) percentages of inside skirt, chuck roll, flank steak, and short plate. Overall, zilpaterol supplementation increased (3.2%, P < .10) the yield of subprimal cuts as a percentage of carcass weights.

Implications

Zilpaterol supplementation can have marked beneficial effect on growth performance of feedlot steers, enhancing weight gain and feed efficiency by approximately 28%. However, because as much as one third of the increase in weight gain can be attributable to increased carcass yield (dressing percentage), cattle finished on zilpaterol should be marketed on a grade and yield basis. In addition to growth performance advantages, zilpaterol also will also improve percentage yields of primal and subprimal cuts. Enhanced growth performance accounts for 55% of the net economic value of zilpaterol supplementation (benefit to the feeder), while increased carcass cutability accounts for 45% of the net value (benefit to the meat packer and retailer). Thus, the economic benefit to zilpaterol supplementation will be optimized through integrated production and meat purveying systems.

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Table 1. Ingredient composition of basal diet fed to steers [a]

Item	
Ingredient composition, %	
Alfalfa hay	3.0
Sudan hay	6.0
Wheat straw	3.0
Steam-flaked wheat	73.0
Tallow	5.0
Cane molasses	7.3
Protein-mineral Supplement [b]	2.7
Nutrient composition[c]	
NE, Mcal/kg	
Maintenance	2.17
Gain	1.49
Crude protein, %	12.50
Ether extract, %	7.44
Calcium, %	.88
Phosphorus, %	.34

[a]Dry matter basis.
[b]Contained 50.5%CP and 22% Ca.
[c]Based on tabular values (NRC, 1996).

Table 2. Influence of zilpaterol supplementation on 42-d growth performance of feed lot steers and NE value of the diet.

Item	Control	Zilpaterol[a]	SEM
Days on test	42	42	
Pen replicates	7	7	
Live weight, kg[b]			
Initial	375	371	1.6
Final[cd]	435	455	2.6
Weight gain, kg/d[d]	1.42	1.94	.04
DM intake, kg/d	8.55	8.45	.18
DM intake/gain[d]	6.08	4.37	.20
Diet NE, Mcal/kg			
Maintenance[d]	2.09	2.58	.06
Gain[d]	1.42	1.85	.05
Observed/expected			
Maintenance[d]	.99	1.23	.03
Gain[d]	.99	1.29	.03

[a]6 mg zilpaterol/kg of air dry feed.
[b]Weights reduced 4% to account for digestive tract fill.
[c]Carcass adjusted final weight.
[d]Treatments differ, $P < .01$.

Table 3. Influence of zilpaterol supplementation on carcass characteristics.

Item	Control	Zilpaterol[a]	SEM
Carcass weight, kg[b]	273	286	1.6
Dressing percentage[b]	61.7	63.9	.20
Rib eye area, cm^{2}[c]	82.5	84.7	.80
Fat thickness, cm	.51	.51	.04
KPH,%	2.34	2.36	.02
Marbling score[d]	3.49	3.43	.04
Retail yield	54.0	54.1	.10
Liver abscess	17.1	7.1	4.4

[a]6mg zilpaterol/kg of air dry feed.
[b]Treatments differ, $P < .01$.
[c]Treatments differ, $P < .10$.
[d]Coded: minimum slight = 3, minimum small = 4, etc.

Table 4. Influence of zilpaterol on yield wholesale cuts as a percentage of carcass weight.

Item	Control	Zilpaterol [a]	SEM
Observations	21	21	
Wholesale cuts, % [b]			
Hindquarter			
Round			
Withbone [c]	32.81	31.72	.22
Boneless	34.98	34.56	.43
Sirloin			
Withbone [d]	8.80	9.16	.11
Boneless [c]	7.97	8.53	.14
Shortloin			
Withbone	5.85	5.96	.08
Boneless [d]	7.32	6.74	.18
Flank			
Withtrim	8.75	9.05	.19
Trimless	6.52	6.73	.16
Forequarter			
Rib	9.06	9.33	.27
Chuck			
Withbone	17.98	17.74	.14
Boneless	12.73	12.79	.13
Brisket			
Withtrim	12.11	12.01	.13
Trimless [d]	10.25	9.68	.16
Plate	11.15	11.61	.21
Total			
With trim [c]	73.20	74.44	1.03
Without trim [d]	49.69	51.11	.50

[a]6 mg zilpaterol/kg of air dry feed.
[b]As percentage carcass weight.
[c]Treatments differ, P < .01.
[d]Treatments differ, P < .05.

Table 5. Influence of zilpaterol on yield of subprimal cuts as a percentage of carcass weight.

Item	Control	Zilpaterol [a]	SEM
Observations	21	21	
Subprimal cuts, % [b]			
Tenderloin	1.90	1.89	.03
Knukle especial [c]	9.46	9.78	.13
Inside round [d]	6.03	6.24	.06
Gooseneck round [c]	5.78	5.52	.06
Heel	1.46	1.48	.03
Outside skirt	.96	.91	.02
Inside skirt [c]	.34	.39	.01
Back rib	1.05	1.02	.02
Short plate [d]	1.03	.95	.02
Triangle [d]	.65	.74	.02
Chuck roll [c]	5.32	4.76	.09
Flank steak [c]	.24	.14	.01
Shank	1.63	1.59	.02
Chuck tender	1.62	1.61	.02
Neck [c]	3.72	4.17	.09
Total [e]	49.67	51.13	.50

[a]6 mg zilpaterol/kg of air dry feed.
[b]As percentage carcass weight.
[c]Treatments differ, P < .01.
[d]Treatments differ, P < .05.
[e]Treatments differ, P < .10.