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## BEEF SPECIES: FEED ADDITIVES

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### 0144 Comparison of feed technologies for backgrounding of weaned beef calves.

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The use of feed technologies in supplements is a means to positively affect performance and health status of newly-weaned calves during backgrounding. Our objective was to evaluate the response of weaned calves to different feed technologies in a supplement (CP = 14.6%, TDN = 67%) to improve calf performance and mitigate the stress response observed during weaning and subsequent backgrounding period. At weaning 160 calves (227 + 2.5 kg) were stratified by BW, sex, and breed and were randomly allotted to 1 of 4 treatments ( $n = 40$  calves/treatment): 1) supplemented without feed technologies or control (CON); 2) supplement with added chlortetracycline, 350 mg/d (CTC); 3) supplement with added Rumensin, 175 mg/d (RUM); 4) supplement with added Actigen, 5 g/d (ACT). Calves were held in 1 of 4 drylot treatment pens ( $n = 40$  calves/pen) for 7 d after weaning and offered ad libitum access to hay and 2.27 kg/d of supplement before placement in 1 of 32 0.8-ha pastures (5 calves/pasture) for a total of 8 pastures/treatment and supplemented at 1.0% BW. Calf BW were collected on d 0, 1, 3, 7, 14, 50, 52, 55, 59, and 65. After 44 d on pasture, calves were placed on 2 trucks and transported for 24 h. Upon return, calves were placed in 4 pastures with hay and fed their respective supplements for 14 d. Data were analyzed by the MIXED procedure of SAS. The model included the main effect of treatment, pasture was the experimental unit. During the 7 d after weaning, BW change did not differ ( $P = 0.65$ , -0.53 kg/d) among treatments. Over the 50-d post-weaning period there was no difference ( $P = 0.20$ , 0.52 kg/d) in BW gain response among treatments. After transportation, 7- and 14-d BW change were least ( $P < 0.005$ ) for ACT and CTC (0.04 and -0.13 kg/d) compared to CON and RUM (-0.64 and -0.48 kg/d). Feed cost of gain and profitability ( $P \geq 0.15$ , mean = \$2.49/kg and \$73.51) were not different among treatments. Use of feed technologies did not improve calf performance over CON during a backgrounding period and ACT was as effective as CTC or RUM during a post-transportation period.

**Key Words:** beef, backgrounding, supplement

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### 0145 Effects of dose and duration of ractopamine hydrochloride supplementation on growth performance and carcass characteristics of feedlot heifers. B. M. Edenburn\*<sup>1</sup>, N. A. Pyatt<sup>2</sup> and T. L. Felix<sup>1</sup>, <sup>1</sup>*University of Illinois at Urbana-Champaign, Urbana*, <sup>2</sup>*Elanco Animal Health, Greenfield, IN.*

Previous work has shown that ractopamine hydrochloride improves live BW gains, G:F, and HCW; however, data are lacking regarding duration of feeding 300 mg to heifers on growth performance and carcass characteristics. Objectives of this study were to determine the effects of dose, 0 or 300 mg/hd d<sup>-1</sup>, and duration, 28 or 41 d, of ractopamine hydrochloride (RAC, Optaflexx, Elanco Animal Health, Greenfield, IN) supplementation on growth performance and carcass characteristics of feedlot heifers. Charolais cross heifers ( $n = 128$ ) were blocked by BW into 2 blocks and allotted to 20 pens. Pens were randomly assigned 1 of 4 treatments in a 2 × 2 factorial arrangement: (1) 0 mg RAC/hd d<sup>-1</sup> for 28, (2) 0 mg RAC/hd d<sup>-1</sup> for 41 d, (3) 300 mg RAC/hd d<sup>-1</sup> for 28, or (4) 300 mg RAC/hd d<sup>-1</sup> for 41 d. Heifers were fed a basal diet of 50% dry rolled corn, 20% DDGS, 20% corn silage, and 10% supplement. Ractopamine hydrochloride was top dressed immediately following feed delivery. Cracked corn was removed from the diet and 300 mg RAC per 0.454 kg of ground corn carrier was top dressed. Data were analyzed using the mixed procedures in SAS. There were no day × RAC interactions ( $P \geq 0.31$ ) for heifer growth performance. There was no effect ( $P \geq 0.22$ ) of RAC on DMI, ADG, or G:F; however, feeding 300 mg RAC to increased ( $P = 0.03$ ) final BW by 8.4 kg, regardless of duration fed. There were no day × RAC interactions ( $P \geq 0.27$ ) for heifer carcass characteristics. Furthermore, there were no effects ( $P \geq 0.11$ ) of duration of RAC feeding on heifer carcass characteristics. However, heifers fed RAC had an average increase ( $P < 0.01$ ) of 9 kg of HCW, regardless of duration fed. Heifers fed RAC also had greater ( $P \leq 0.03$ ) LM area and dressing percentage. There was no effect ( $P \geq 0.14$ ) of RAC on marbling, 12th rib fat, KPH, or YG. Therefore, supplementing RAC at 300 mg/hd d<sup>-1</sup> to heifers increased HCW, LM area, and dressing percentage and increased final BW without affecting other measures of performance.

**Key Words:** beef, carcass, heifers, ractopamine

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### 0146 A meta-analysis of zilpaterol and ractopamine effects on feedlot. I. J. Lean<sup>1</sup>, J. M. Thompson<sup>2</sup> and F. R. Dunshea\*<sup>3</sup>, <sup>1</sup>*SBScibus, Camden, Australia*, <sup>2</sup>*The University of New England, Armidale, Australia*, <sup>3</sup>*The University of Melbourne, Parkville, Australia.*

This study is a meta-analysis of the effects of the  $\beta$ -agonists zilpaterol hydrochloride (ZH) and ractopamine hydrochloride (RAC) on feedlot performance, carcass characteristics of cattle and Warner Bratzler shear force (WBSF) of muscles. It was

conducted to provide data that would be useful in considerations on the effect of these agents on meat quality in Meat Standards Australia evaluations. We conducted a comprehensive literature search and study assessment. Data were extracted from more than 50 comparisons for both agents and analyzed using a random effects meta-analysis and meta-regression using Stata (Stata 13.0). Results included forest plots, funnel plots, raw and weighted means, and estimates of effects size for each of ZH or RAC, independently. There was little evidence of publication bias on evaluation of funnel plots. Both agents markedly increased final body weight as indicated by the effect size (ES) 0.45 95% confidence interval (95% CI) 0.28 to 0.62 and weighted mean difference (wmd) 8.15 kg, (95% CI 5.63 to 10.67 kg) for ZH, RAC ES 0.40 (95% CI 0.24 to 0.56) and wmd 7.67 kg (95% CI 5.58 to 9.55 kg), hot carcass weight for ZH ES 1.32 (95% CI 1.03 to 1.61) and wmd 15.18 kg (95% CI 13.62 to 16.74 kg), RAC ES 0.47 (95% CI 0.31 to 0.63) wmd 6.18 kg (95% CI 4.55 to 7.82 kg) and longissimus muscle area (ZH ES 2.30 (95% CI 1.90 to 2.71) wmd 8.01 cm<sup>2</sup> (95% CI 7.05 to 8.96 cm<sup>2</sup>), RAC ES 0.39 (95% CI 0.20 to 0.58) wmd 1.84 cm<sup>2</sup> (95% CI 1.17 to 2.52 cm<sup>2</sup>) and increased the efficiency of gain:feed ratio (ZH ES 0.88 (95% CI 0.67 to 1.11) wmd 0.15 kg (95% CI 0.11 to 0.19), RAC ES 0.77 (95% CI 0.58 to 0.96) wmd 0.018 kg (95% CI 0.014 to 0.022)). These effects were particularly large for ZH; however, ZH decreased fatness (by either ribfat or marbling score) with an ES of about -0.8 SD. For RAC the effects on fatness were much smaller with an ES of 0.0 and -0.1 for ribfat and marbling score, respectively. Zilpaterol also markedly increased WBSF by 1.2 standard deviations and more than 0.8 kg, while RAC increased WBSF by 0.43 standard deviations and 0.2 kg. This work has provided critically needed information on the effects of ZH and RAC on production, efficiency and meat quality.

**Key Words:** zilpaterol hydrochloride, ractopamine hydrochloride, meta-analysis

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#### 0147 Evaluation of objective and subjective mobility variables in feedlot cattle supplemented with zilpaterol hydrochloride. W. C. Burson<sup>1</sup>,

A. J. Thompson<sup>1</sup>, M. A. Jennings<sup>1</sup>, J. A. Carroll<sup>2</sup>, N. C. Burdick Sanchez<sup>2</sup>, B. J. Ragland<sup>1</sup>, J. E. Hergenreder<sup>1</sup>, J. O. Baggerman<sup>1</sup>, K. S. Sharon<sup>1</sup>, T. R. Schmidt<sup>1</sup>, E. S. Murray<sup>1</sup>, F. R. B. Ribeiro<sup>1</sup>, B. J. Johnson<sup>1</sup>, and R. J. Rathmann<sup>1</sup>, <sup>1</sup>Texas Tech University, Lubbock, <sup>2</sup>USDA-ARS, Livestock Issues Research Unit, Lubbock, TX.

The objective of this study was to examine the effects of zilpaterol hydrochloride (ZH) on mobility in feedlot cattle. Black-hided steers and heifers ( $n = 96$ ) were sourced from a commercial feedlot and transported to the Texas Tech University Beef Center in New Deal, TX. Cattle were weighed and scanned using real-time ultrasound. Resulting data were used to predict empty body fat percentage (pEBF %). Steers ( $n = 48$ ; BW =

520 ± 30.4 kg; pEBF % = 26.2 ± 1.9) and heifers ( $n = 48$ ; BW = 466 ± 29.5 kg; pEBF % = 26.7 ± 1.7) were blocked within gender by pEBF % in a completely randomized block design and randomly assigned to pen (2 pens/block; 4 hd/pen) and treatment (6 pens/treatment): 1) control heifers (HC), 2) ZH heifers (HZ), 3) control steers (SC), 4) ZH steers (SZ). Movement differences were objectively assessed on Day 0, 5, 10, 15, and 20 with several measures of mobility: exit velocity from chute (EV), velocity traveling from the pen to chute (VT) and velocity traveling from chute to pen (VF). Chute scores (CS) were assigned to all cattle based on a scale ranging from 1 to 5 (1 = no distress, 5 = high distress). Before shipping, individual locomotion scores (LS) were recorded based on a 1 to 4 scale (1 = no lameness, 4 = severe lameness). No significant gender × treatment interactions were found for any measured variable ( $P \geq 0.46$ ). A significant treatment × day interaction ( $P = 0.03$ ) was detected for EV, indicating that ZH cattle became progressively slower throughout the treatment period. No significant effects were found for VT or VF ( $P \geq 0.31$ ). Fisher's exact test for count data was used to analyze the frequency distributions for both subjective measures. On d 20, a greater proportion ( $P = 0.01$ ) of ZH cattle exhibited elevated chute scores ( $CS \geq 3$ ) relative to control. There was a tendency ( $P = 0.09$ ) for increased locomotion score ( $LS \geq 2$ ) in ZH fed cattle. However, the proportion of cattle with locomotion scores indicating sufficiently sound movement ( $LS = 1&2$ ) versus cattle that were moderate or severely lame ( $LS = 3&4$ ) was not significantly different between treatment groups ( $P = 0.24$ ). These data suggest that ZH supplementation may slightly limit mobility of cattle; nonetheless, the magnitude of these effects is not sufficient to deduce a detriment to cattle soundness.

**Key Words:** cattle, zilpaterol hydrochloride, mobility

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#### 0148 Comparison of real-time ultrasound measurements for body composition traits to carcass data in feedlot cattle fed zilpaterol hydrochloride.

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The objective of this study was to compare measurements of real-time ultrasound (RTU) and carcass data to determine body composition in feedlot cattle ( $n = 96$ ) fed zilpaterol hydrochloride (ZH). Black-hided cattle were weighed and scanned using RTU 32 d before the start of the ZH treatment period. Resulting data were used to predict empty body fat (EBF %). Steers ( $n = 48$ ; BW = 520 ± 30.4 kg; EBF % = 26.2 ± 1.9) and heifers ( $n = 48$ ; BW = 466 ± 29.5 kg; EBF % = 26.7 ± 1.7) were blocked within gender by EBF % in a complete randomized block design and randomly assigned to pen (2 pens/block; 4 hd/pen) and treatment (6 pens/treatment). Measurements of RTU were taken by a certified ultrasound technician approximately 24 h before slaughter using an Aloka 500-V instrument with a 17-cm 3.5 MHz transducer. Hair was clipped

to less than 0.64 cm and vegetable oil was applied. The RTU measured traits consisted of 12-13th rib backfat thickness (uBF, mean = 12.4 mm), 12--13th LM area (uREA, mean = 93.9 cm<sup>2</sup>), and marbling score (uMARB, mean = 5.1). Intramuscular fat was converted to uMARB by using the equation: uMARB = ((769.7 + (56.69×uIMF))/100)– 5. Overall means for carcass data were 12-13th rib backfat thickness (cBF, 13.6 mm), 12-13th LM area (cREA, 92.0 cm<sup>2</sup>; measured using tracing paper), and marbling score (cMARB, 5.2). Marbling scores were converted to a numeric cMARB (Slight<sup>00</sup> = 4, Small<sup>00</sup> = 5, and Modest<sup>00</sup> = 6). Data were analyzed using the PROC REG, MEANS and CORR procedures of SAS. Results show that both methods were highly correlated to each other. Overall correlations were 0.83, 0.61, and 0.69 for BF, REA and MARB, respectively. The accuracy statistics for cattle (heifers and steers pooled together) fed ZH and Control were almost identical. Correlations for ZH and control cattle were 0.83, 0.60, 0.68 and 0.83, 0.59, 0.70 for BF, REA, MARB for ZH, respectively. The low correlation for REA could be a result of the method of collecting carcass REA data. Overall RTU underpredicted BF and MARB and overpredicted REA (bias = -1.32, -0.18 and 1.47, respectively). These results show that RTU can be used to predict carcass traits before slaughter and feeding ZH seems to have no effect in predicting carcass traits using RTU in live animals.

**Key Words:** ultrasound, carcass traits, zilpaterol hydrochloride

#### 0149 The effect of zilpaterol supplementation and RFI on growth performance.

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Supplementation of zilpaterol hydrochloride (ZH) impacts live cattle performance. Research has not focused on individual intake or the impact on residual feed intake (RFI) when cattle are supplemented ZH. A 308 d serial-harvest trial was conducted in Holstein steers ( $n = 110$ ) blocked by 11 harvest dates (d 252–534) and assigned to ZH or control treatments ( $n = 5$  per treatment per harvest). Individual DMI was collected using the GrowSafe system and rations were sampled monthly for proximate analysis (CP =  $14.5 \pm 0.7$ ; NE<sub>m</sub> =  $2.2 \pm 0.1$  Mcal/kg; NE<sub>g</sub> =  $1.5 \pm 0.03$  Mcal/kg). Every 28 d, DMI, ADG and SBW (BW\*0.96) were calculated. Within each 28 d period, before ZH supplementation, RFI was calculated for each steer with a regression equation (coefficients of metabolic BW and shrunk BW gain); steers were assigned to a high or low RFI. Statistical analysis for data generated before ZH supplementation was conducted using a mixed model with fixed effects of RFI and days on feed (DOF) and random effects of harvest group and head count per feeding node; DOF was a repeated measure. Analysis of data during the ZH sup-

plementation period was conducted using a mixed model with the fixed effects of ZH, DOF, and RFI and the random effect of harvest group. Intake before ZH supplementation was associated with RFI ( $P < 0.01$ ); the high group consumed more DM than the low group (10.7 vs. 9.4 kg). A quadratic relationship between DMI and DOF was observed ( $P < 0.01$ ); an inflection point occurred at Day 392. Gain efficiency (G:F) was also influenced ( $P < 0.01$ ) by RFI; steers in the high RFI exhibited a G:F of 0.13 whereas low RFI steers were 0.15. As DOF increased, ADG and G:F exhibited a linear decrease ( $P < 0.01$ ). During the ZH supplementation period, steers of the high RFI consumed more DM ( $P < 0.01$ ; 10.6 vs. 9.5 kg) than those of the low RFI. However, steers supplemented ZH consumed less ( $P = 0.03$ ) DM (9.7 vs. 10.3 kg). No ZH x RFI interaction ( $P = 0.42$ ) was observed for DMI. Daily gain was not different ( $P \geq 0.22$ ) between ZH treatments or RFI group. However, G:F tended ( $P = 0.07$ ) to be greater for steers supplemented ZH; RFI did not affect G:F ( $P = 0.39$ ).

**Key Words:** DMI, RFI, zilpaterol

#### 0150 Effects of zilpaterol hydrochloride on internal body temperature and respiration rate of black-hided feedlot steers and heifers during moderate heat stress.

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The objective of this study was to examine the effects of zilpaterol hydrochloride (ZH) on the internal body temperature and respiration rate of feedlot cattle during moderate heat stress. Black-hided steers and heifers ( $n = 96$ ) were sourced from a commercial feedlot and transported to the Texas Tech University Beef Center in New Deal, TX. Cattle were weighed and scanned using real-time ultrasound. Resulting data were used to predict empty body fat percentage (pEBF %). Steers ( $n = 48$ ; BW =  $520 \pm 30.4$  kg; pEBF % =  $26.2 \pm 1.9$ ) and heifers ( $n = 48$ ; BW =  $466 \pm 29.5$  kg; pEBF % =  $26.7 \pm 1.7$ ) were blocked within gender by pEBF % in a completely randomized block design and randomly assigned to pen (2 pens/block; 4 hd/pen) and treatment (6 pens/treatment): 1) control heifers (HC), 2) ZH heifers (HZ), 3) control steers (SC), and 4) ZH steers (SZ). During the ZH treatment period the climatic conditions were: mean maximum temperature, 29.67°C; mean minimum temperature, 15.18°C; mean relative humidity, 60.69%; mean wind velocity, 8.37 km/h. Immediately preceding the ZH treatment period (d -1), cattle were fitted with an indwelling rectal temperature probe. Rectal temperatures (RT) were recorded at 5-min intervals throughout the treatment period. Panting scores (PS) were assigned to cattle every other day from 1500



to 1700 h during the ZH treatment period based on a scale ranging from 1 to 4 (1 = normal respiration, 4 = extremely elevated respiration). Repeated measures analysis of RT revealed a significant treatment  $\times$  gender interaction ( $P < 0.0001$ ). The HC group recorded higher RT relative to the HZ group ( $P \leq 0.0009$ ; 38.83°C versus 38.76°C, respectively). Alternatively, the SC group recorded lower RT relative to the SZ group ( $P \leq 0.0009$ ; 38.96°C versus 38.98°C, respectively). Although highly significant differences were detected for RT, the marginal effect size may be insufficient to deduce biologically significant implications. Fisher's exact test for count data was used to analyze the frequency distribution of PS. No differences were detected in PS between treatments at any single point of data collection or for the entire treatment period ( $P \geq 0.32$ ). Collectively, the variables measured in the present study do not provide compelling evidence to suggest that ZH treated black-hided cattle of either sex have more difficulty coping with moderate heat stress relative to their control counterparts.

**Key Words:** cattle, zilpaterol hydrochloride, heat stress

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#### 0151 Effects of zilpaterol hydrochloride on blood gas, electrolyte balance and pH in feedlot cattle.

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The objective of this study was to examine the effects of zilpaterol hydrochloride (ZH) on blood gas, electrolyte balance and pH in feedlot cattle. Black-hided steers and heifers ( $n = 96$ ) were sourced from a commercial feedlot and transported

to the Texas Tech University Beef Center in New Deal, TX. Cattle were weighed and scanned using real-time ultrasound. Resulting data were used to predict empty body fat percentage (pEBF %). Steers ( $n = 48$ ; BW = 520  $\pm$  30.4 kg; pEBF % = 26.2  $\pm$  1.9) and heifers ( $n = 48$ ; BW = 466  $\pm$  29.5 kg; pEBF % = 26.7  $\pm$  1.7) were blocked within gender by pEBF % in a completely randomized block design and randomly assigned to pen (2 pens/block; 4 hd/pen) and treatment (6 pens/treatment): 1) control heifers (HC), 2) ZH heifers (HZ), 3) control steers (SC), 4) ZH steers (SZ). Venous blood was collected in lithium heparinized tubes through the use of jugular venipuncture on Day 5, 10, 15, and 20 of the ZH treatment period. Blood samples were placed on ice and transported to an on-site station for prompt analysis. Data were analyzed as repeated measures to assess effects due to treatment. ZH treatment significantly increased potassium (K) concentration ( $P < 0.0001$ ). Calcium (Ca) concentration was reduced in both genders, but, a significant gender  $\times$  treatment interaction ( $P = 0.0376$ ) revealed that ZH decreased Ca with a greater magnitude in steers relative to heifers. ZH treated cattle expressed a tendency for a lower partial pressure of oxygen (pO<sub>2</sub>;  $P = 0.082$ ) relative to control. No significant gender  $\times$  treatment interactions or main effects were detected ( $P \geq 0.14$ ) for blood pH, partial pressure of carbon dioxide (pCO<sub>2</sub>), oxygen saturation (SO<sub>2</sub>C), sodium (Na) concentration or percentage of hematocrit (Hct). Collectively, these data suggest that only minor differences exist between ZH and control cattle with respect to blood gases and pH, such that a causative effect cannot be assumed. The alterations in K and Ca indicate that biologically significant differences in the cation-anion difference (CAD) may exist when comparing treatment groups. Furthermore, the significant reduction in blood Ca concentration in ZH treated cattle provides more insight to the well-known reduction in post-mortem tenderness associated with cattle fed a  $\beta$ -adrenergic agonist.

**Key Words:** cattle, zilpaterol hydrochloride, blood gas