Growth performance and carcass characteristics in finishing feedlot heifers fed different levels of chromium-enriched live yeast or fed zilpaterol hydrochloride

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Sixty crossbred heifers (371 ± 7 kg) were used in a 63-d feeding trial (4 pens per treatment in a randomized complete block design) to evaluate the influence of dietary supplementation with zilpaterol hydrochloride (β-agonist) or with different levels of chromium-enriched live yeast (Cr-YC) on growth performance and carcass characteristics. Heifers were fed a diet based on steam-flaked corn (1.45 Mcal of net energy of gain, NEg kg^{-1}). Treatments were: 1) control, no yeast, no zilpaterol supplementation (Ctrl); treatments 2, 3 and 4) were the same basal diet supplemented with a commercial Cr-YC for a final dose of 10, 20 or 30 g hd^{-1} d^{-1} of yeast strain, and 5) the same basal diet (Ctrl) supplemented with 6 mg of zilpaterol kg^{-1} of feed for 30 d (ZIL), drug withdrawn from the diet 3 d pre-harvest. Compared with controls, ZIL increased final weight (3.8 %, $P < 0.03$), carcass-adjusted daily gain (18.7 %, $P = 0.05$), apparent dietary net energy of maintenance (14 %, $P < 0.01$), and decreased observed/expected DMI (14 %, $P < 0.01$). Treatment with ZIL did not affect ($P < 0.13$) marbling score, but, compared with control group, increased carcass dressing percentage (2.6 %, $P = 0.01$), and reduced ($P = 0.02$) kidney, pelvic and heart fat (KPH, 19.8 %) and fat thickness (9.4 %) and tended (5.9 %, $P = 0.06$) to increase Longissimus muscle area. Compared with Cr-YC treatments, ZIL increased apparent dietary NEm ($P = 0.03$) and dressing percentage ($P < 0.01$), and decreased observed/expected DMI ($P = 0.03$) and KPH ($P=0.04$). Treatment with Cr-YC did not affect carcass characteristics, but compared with control, Cr-YC supplementation tended to increase final BW ($P = 0.08$), ADG (0.09), fed:gain ratio (F:G, $P = 0.08$) and dietary NE ($P = 0.06$). Level of supplemental Cr-YC increased (linear component, $P \leq 0.04$) final BW, ADG, F:G, apparent dietary NEm, and decreased ($P = 0.02$) observed/expected DMI. Level of supplemental Cr-YC did not affect ($P \geq 0.33$) dressing percentage, LM area or marbling score, but, fat thickness and KPH decreased ($P = 0.02$) as Cr-YC level supplementation increase. DMI and HCW tended ($P \leq 0.08$) to increase with increasing Cr-YC supplementation level. It is concluded that, zilpaterol supplementation increase growth performance in heifers as results of greater muscle accretion and for reduction of body fat. Chromium-enriched yeast supplementation increase growth performance and dietary NE, with modest effect in carcass characteristics. Better responses were observed at level of Cr-YC supplementation of 30 g hd^{-1} d^{-1} that corresponds to daily intakes of 1.65×10^{11} colony forming units and 15 mg chromium.

Key words: *finishing cattle, β-agonist, direct-fed microbials, feed efficiency, carcass traits*.

The use of zilpaterol hydrochloride (a β-agonist) as feed additive to improve growth performance and carcass characteristics in feedlot cattle is common in Mexico and USA (Plascencia *et al*. 2008). However, the use as feed additive of this kind of compound is forbidden in the Europe Union (Council of the European Communities 1986) and many other countries. The concern over the use of antibiotics and other growth stimulants in feed for production of food has increased interest in evaluating the effect of directly fed microbials such as yeasts (YC). YC supplementation enhancing growth performance, nitrogen balance, and nutrient digestion in ruminants fed high-energy diets (Krehbiel *et al*. 2003 and Haddad and Goussous 2005); however, these results have been inconsistent (Romero *et al*., 2010). Some research reported that the efficacy of YC supplementation depends, in part, on level of administration (Domínguez-Vara *et al*. 2009) and by the type of YC utilized (alone or combines with minerals such Se and chromium; Kellems *et al*. 1990). Previous reports indicate that chromium (Cr) improves percentage of muscle and decreased carcass fat in pigs (Jackson *et al*. 2009). Therefore, positive effects from the use of chromium-enriched yeast (Cr-YC) on productive performance and carcass characteristics can be expected. Limited research has been done on compare the use of β-agonist zilpaterol with the use of different levels of supplemental Cr-enriched live yeast in finishing feedlot cattle.

The objective of this experiment was to evaluate growth performance and carcass characteristics responses in heifers fed zilpaterol or fed Cr-YC.

Materials and Methods

All procedures involving live animals were conducted within the guidelines of approved local official techniques of animal care (Normas Oficiales Mexicanas, NOM-051-ZOO-1995: Humanitarian care of animals during mobilization of animals; NOM-024-ZOO-1995: Animal health stipulations and characteristics during transportation of animals; NOM-EM-015-ZOO-2002: Technical stipulations for the control use of beta agonists in animals, and NOM-033-ZOO-1995, Humanitarian care and animal protection during slaughter process).

Sixty crossbreed heifers (371± 7 kg) approximately 20% Zebú breeding with the remainder represented by Hereford, Angus, and Charolais breeds in various proportions, were used in a 63-d growth performance trial to evaluate the treatment effects on growth performance and carcass characteristics. The trial was conducted at the Feedlot Experimental Unit of the Instituto de Investigaciones en Ciencias Veterinarias of the Universidad Autónoma de Baja California located 10 km south of Mexicali City in northwestern México (32° 40' 7"N and 115° 28' 6"W) is about 10 m above sea level, and has Sonoran desert conditions (BWh classification according Köppen). The origin of cattle was a commercial feedlot located at 7 km from Feedlot Experimental Unit. Sixty seven days before the trial started, heifers were vaccinated for bovine rhinotracheitis-parainfluenza and *Mannheimia haemolityca* (Pirámide 4 + Presponse SQ®, Fort Dodge, Animal Health, México), clostridials (Ultrabac-7®, Pfizer Animal Health, México), and treated for parasites (Bimectin®, Vetoquinol, México). Heifers were injected with 500,000 IU vitamin A (Synt-ADE®, Fort Dodge, Animal Health, México) and implanted with 200 mg of testosterone propionate and 20 mg of estradiol benzoate (Synovex H®, Fort Dodge, Animal Health, México). Cattle arrived to Feedlot Experimental Unit 14 days before the trial started, heifers were weighed, reimplanted with 200 mg of trembolone acetate and 28 mg of estradiol benzoate (Synovex plus®, Fort Dodge, Animal Health, México) and sorted by arrival LW from lightest to heaviest, and were blocked by weight and randomly assigned within weight groups to 20 pens (three heifers per pen). Pens were 50 m^2 with 21 m^2 overhead shade, automatic waterers and 3.7 m fence-line feed bunks. Cattle were weighed at arrival, at start of experiment and before heifers were shipped to a commercial abattoir (Rastro TIF 105) located 14 km from de Feedlots Experimental Unit facilities. Individually LW was recorded at 0600 h, the maximal time spent to weight all

Table 1. Composition of experimental diets (DM basis)

Items	Treatments[1]				
	Control	Cr-YC10	Cr-YC20	Cr-YC-30	ZIL
Sudangrass hay	8.00	8.00	8.00	8.00	8.00
Wheat straw	6.50	6.50	6.50	6.50	6.50
Steam-flaked yellow corn	63.60	63.60	63.60	63.60	63.60
Cottonseed meal	6.00	6.00	6.00	6.00	6.00
Cane molasses	10.00	10.00	10.00	10.00	10.00
Tallow	3.00	3.00	3.00	3.00	3.00
Urea	0.80	0.80	0.80	0.80	0.80
Limestone	1.50	1.50	1.50	1.50	1.50
Trace mineral salt[2]	0.40	0.40	0.40	0.40	0.40
Magnesium oxide	0.20	0.20	0.20	0.20	0.20
Yeast supplemented, g^{-1} hd^{-1} d^{-1}	0.00	10.00	20.00	30.00	0.00
Zilpaterol hydrochloride, 6 mg kg^{-1} of feed, air dry basis	0.00	0.00	0.00	0.00	+++
Nutrient composition, DM basis[3]					
NEm, Mcal kg^{-1}	2.11	2.11	2.11	2.11	2.11
NEg, Mcal kg^{-1}	1.45	1.45	1.45	1.45	1.45
CP, %	12.50	12.50	12.50	12.50	12.50
EE, %	6.20	6.20	6.20	6.20	6.20
Ca, %	0.72	0.72	0.72	0.72	0.72
P, %	0.33	0.33	0.33	0.33	0.33

[1]Source of yeast used were Ganadero-Plus and Beef -8 Ways (Biotecap®, Guadalajara, México) and were fed daily in 50:50 proportion of total dose offer during all experiment. ZIL= 6 mg/kg of feed of zilpaterol hydrochloride; Zilmax®, Intervet, México City, México. Zilpaterol was fed daily in feed for 30 d, drug withdrawn from the diet 3 d pre-harvest. [2] Trace mineral salt contained: $CoSO_4$, 0.068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, 1.24%; $MnSO_4$, 1.07%; KI, 0.052%; and NaCl, 92.96%. [3]The estimation was based on tabular values for individual feed ingredients (NRC, 1996).

Table 2. Treatments effects on growth performance in feedlot heifers

Item	Control	Level of yeast supplementation[1], $g^{-1}\ hd^{-1}d^{-1}$				SEM	P[2] value			Cr-YC level	
		Cr-YC10	Cr-YC20	Cr-YC30	ZIL		C vs. YS	C vs. ZIL	Cr-YC vs. ZIL	Lin	Qua
Days on test	63.0	63.0	63.0	63.0	63.0						
Pen replicates	4.0	4.0	4.0	4.0	4.0						
Live weight, kg[3]											
Initial	371.2	371.7	369.2	370.4	371.3	2.670	0.80			0.75	0.58
Final	447.7	448.7	460.3	468.8	465.3	5.170	0.08	0.03	0.34	0.02	0.82
Weight gain, kg d^{-1}	1.213	1.223	1.446	1.562	1.493	0.093	0.09	0.05	0.45	0.04	0.65
DM intake, kg d^{-1}	8.08	8.09	8.44	8.64	8.07	0.206	0.22	0.99	0.22	0.08	0.76
Gain/DM intake	0.150	0.152	0.171	0.180	0.185	0.008	0.08	0.01	0.09	0.03	0.60
DM intake/gain	6.67	6.66	5.92	5.59	5.43	0.328	0.09	0.01	0.08	0.03	0.57
Observed diet energy, Mcal kg^{-1}											
Maintenance	2.11	2.13	2.26	2.34	2.45	0.056	0.06	<0.01	0.03	0.02	0.75
Gain	1.44	1.46	1.57	1.64	1.71	0.049	0.06	<0.01	0.03	0.02	0.75
Observed-to-expected diet NE[4]											
Maintenance	1.00	1.02	1.08	1.12	1.15	0.026	0.06	<0.01	0.03	0.02	0.75
Gain	1.01	1.02	1.10	1.15	1.19	0.034	0.06	<0.01	0.03	0.02	0.75
Observed-to-expected DMI[5]	1.00	1.00	0.93	0.90	0.86	0.028	0.06	<0.01	0.03	0.02	0.69

[1]Source of yeast used were Ganadero-Plus and Beef -8 Ways (Biotecap®, Guadalajara, México) and were fed daily in 50:50 proportion of total dose offer during all experiment. ZIL= 6 mg/kg of feed of zilpaterol hydrochloride; Zilmax®, Intervet, México City, México. Zilpaterol was fed daily in feed for 30 d, drug withdrawn from the diet 3 d pre-harvest.

[2]P = Observed significance level for effect of treatments (C vs. Cr-YC=Control vs. averaged observed of all Yeast treatment, C vs. ZIL = control vs. zilpaterol supplementation, Cr-YC vs. ZIL= averaged observed of all Yeast treatment vs. zilaperol supplementation, and lineal and quadratic effect of level of yeast supplementation).

[3]Initial and final weight reduced 4% to account for fill.

[4]Expected diet NE based on tabular values for individual dietary ingredients (NRC 1996).

heifers was 85 ± 5 min. Heifers were fed a steam-flaked corn-based diet (table 1) and were adapted to the basal diet 14 days before the trial started. Treatments were: 1) control, no yeast, no zilpaterol supplementation (Ctrl); treatments 2, 3 and 4) were the same basal diet supplemented with a mixture of equal parts of two strains of chromium-enriched yeast culture (Cr-YC) for a final dose of 10 (Cr-YC10), 20 (Cr-YC20) or 30 (Cr-YC30) g hd^{-1} d^{-1} of yeast strain, and 5) the same basal diet (Ctrl) supplemented with 6 mg of zilpaterol kg^{-1} of feed for 30 d, drug withdrawn from the diet 3 d pre-harvest.

The yeast (*Saccharomyces cerevisiae* N. strain 7907) used were the commercial trade Cattle-Plus® and organic chromium mineral-enriched yeast; Beef-8-Ways® (Biotecap®, Guadalajara, México). The net concentration of chromium (as chromium-niacine) of mineral live yeast was 495 ppm. The source of zilpaterol hydrochloride was Zilmax® (Intervet, México City, México) and was supplemented to provide approximately 0.15 mg kg^{-1} BW daily, based on expected average BW of heifers during the 30-d supplementation period. Doses of Cr-enriched yeast or zilpaterol were hand-weighed in a precision balance (Ohaus, mod AS612, Pine Brook, NJ). The total daily dose of feed additives was provided in the morning feeding as part of the complete mixed diet. This was accomplished by combining the additives with the basal diet (table 1) in a 90-kg capacity paddle mixer (Leon Weill mixer, model 30910-7, Coyoacán, México) and mixing for 10 min before feeding to cattle. Heifers were fed twice daily at 8:00 am and 2:00 pm in a 30:70 proportion, approximately 3 kg /heifer d^{-1} (as feed basis) in the morning meal with bunk management designed to result in empty bunks at feeding before served the afternoon meal. Feed bunks of each pen in the trial were evaluated visually between 7:40 to 7:50 each morning before feeding to determine the quantity of feed remained in the previous day. The process was designed to allow the minimal accumulation in the feed bunk. The adjusted (increased or decreased) delivery was in the portion assigned in afternoon meal. To ensure that yeast and zilpaterol daily doses were completely fed, the doses of each one was served totally in the morning meal. Feed samples were collected at the time of the diet was weighed for each pen, begged in plastic bags and stored at 4°C. To determine DM intake, DM content of diet was determined of composite samples at weekly intervals (drying overnight at 100°C in a forced-air oven; AOAC 2000).

Hot carcass weights (HCW) were obtained from all heifers at time of slaughter. After carcasses were chilled for 48 h the following measurements were obtained: 1) Longissimus muscle (LM) area, taken by direct grid reading of the muscle at 12th rib taken at the location, three-quarters of the length laterally from the backbone end; 2) subcutaneous fat over the ribeye 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). Energy gain (EG, Mcal/d) was calculated by the equation: $EG = ADG^{1.097} * 0.0608\ BW^{0.75}$ (NRC, 1984). Maintenance energy (EM) was calculated by the equation: $EM = 0.077\ BW^{0.75}$ (Garrett 1971). From the derived estimates of energy required for maintenance and gain, the NEm and NEg values of the diet were obtained using the quadratic formula: $(-b - \sqrt{b2 -4ac})/2c$; where a = -0.41EM, b = 0.877EM + 0.41DMI + EG, and c = -0.877DMI, and NEg = 0.877NEm - 0.41 (Plascencia and Zinn 2002). For calculating steer performance, initial and final full weights were reduced 4% to account for digestive tract fill. Final weight was adjusted for carcass weight by dividing individual carcass weights by the average dressing percentage for all heifers. Pens were used as experimental units. Pen performance and carcass data were analyzed as a randomized complete block using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Pen was the experimental unit. Treatment effects were separated by means of orthogonal polynomials (Morris 1999). Treatment effects were tested for the following orthogonal components: 1) Ctrl vs. averaged observed of all Yeast treatment (Cr-YC); 2) Ctrl vs. ZIL; 3) Cr-YC vs. ZIL and 4) linear and quadratic component of Cr-YC supplementation level. Contrasts were considered significant when the P-value was ≤ 0.05, when tendencies identified when P-value was >0.05 and ≤0.10.

Results and Discussion

Dry matter intake (DMI) (table 2) averaged 8.264 ± 0.715 kg d^{-1} was not affected ($P \geq 0.08$) by treatments. Based on observed DMI, daily zilpaterol intake averaged 0.130 ± 0.001 mg kg^{-1} BW. For yeast treatments, daily intake of colony-forming unit (CFU) averaged: 5.5×10^{10}, 1.10×10^{11}, and 1.65×10^{11}, while chromium, daily intake (mg) averaged 4.95, 9.90 and 14.85, for treatments Cr-YC10, Cr-YC20 and Cr-YC30, respectively. Compared with controls, ZIL increased final body weight (BW; 3.8%, $P < 0.03$), carcass-adjusted average daily gain (ADG; 18.7%, $P = 0.05$), and apparent dietary net energy of maintenance (NEm ; 14%, $P < 0.01$) with no effect ($P=0.99$) on DMI. Improved ADG, gain for feed (G:F) and dietary net energy (NE) has been a consistent response to zilpaterol supplementation of feedlot steers and feedlot heifers (Plascencia *et al.* 2008, Elam *et al.* 2009 and Robles-Estrada *et al.* 2009). However, effects of ZIL supplementation on DMI have been inconsistent. In some studies (Avendaño-Reyes *et al.*

2006, Plascencia *et al*. 2008 and Robles-Estrada *et al*. 2009), similar to our results, ZIL supplementation did not affect DMI. Whereas, in other studies ZIL supplementation resulted in modest (2 to 6.2%) depressions (Vasconcelos *et al*. 2008, Montgomery *et al*. 2009 and Holland *et al*. 2010). Observed DMI of control (non-supplemented) heifers was 100% of expected based on tabular (NRC 1996) estimates of diet energy density and observed shrunk body weight (SBW) and ADG (table 3), supporting the practicality of the prediction equations proposed by the NRC (1996) for estimation of DMI in relation of SBW and ADG in feedlot cattle. Compared to controls, ZIL supplementation decreased (14 %, P = 0.01) observed:expected DMI ratio, identical with the average of 14% reported for continental-crosses heifers by Montgomery *et al*. (2009), but 55% lower than those (31 %) reported by Robles-Estrada *et al*. (2009) in crossbreed heifers. The basis for differences in the magnitude of performance response with zilpaterol supplementation is not certain, but may reflect differences in dosage level and in final BW and mature muscle mass. Compared with study performed by Robles-Estrada *et al*. (2009), in the present experiment, heifers had 10% lower final BW at harvest, and daily intake of zilpaterol was 15% lower than recommended dosage level of 0.15 mg kg BW d^{-1} (FDA 2006). The apparent increase in energy retention per unit DMI in cattle fed zilaterol is a reflection of the direct action of supplemental β-agonist on net protein retention, and hence, lean tissue growth (Moody *et al*. 2000, Murdoch *et al*. 2005 and Johnson and Chung 2007).

Treatment with ZIL did not affect (P < 0.13) HCW or marbling score, but, compared with control group, ZIL treatment increased carcass dressing percentage (2.6%, P = 0.01), and reduced (P = 0.02) KPH (19.8%) and fat thickness (9.4%) and tended to increase (5.9%, P=0.08) LM area. Some increase in LM area was expected due to numerically differences in carcass weights (table 3; Block *et al*. 2001). Increased dressing percentage, and decreased internal fat (KPH) has been a consistent response to ZIL supplementation in feedlot cattle (Plascencia *et al*. 2008, Montgomery *et al*. 2009 and Neill *et al*. 2009). HCW of ZIL heifers was numerically heavier (4.1%, P =0.13) compared with controls. The magnitude of HCW response to zilpaterol supplementation ranging from 3.42 (Montgomery *et al*., 2009) to 6.98% (Avendaño-Reyes *et al*. 2006) with an average of 4.6% (Avendaño-Reyes *et al*. 2006, Plascencia *et al*. 2008, Kellermeier *et al*. 2009, Robles-Estrada *et al*. 2009 and Montgomery *et al*. 2009).

ZIL treatments did not differ (P ≥ 0.09) from Cr-YC treatment on final BW, ADG or feed efficiency. To our knowledge, one study was conducted to compare beta-agonists vs. mineral-enriched yeast. Romero *et al*. (2010) reported that, compared with Cr-YC treatment, ZIL group had greater (P < 0.05) ADG and feed efficiency. However, unfortunately, these researches do not report the CFU concentration used and, compared with the present study, they utilized 10 % of dosage level of chromium in diet (0.187 vs. 1.719 mg kg^{-1} of diet).

ZIL supplementation resulted in greater (P = 0.03) dietary NE (8.4 %) and observed:expected DMI ratio (6.7 %) than Cr-YC supplemented heifers. As discussed previously, the apparent increase in energy retention per unit DMI in cattle fed zilaterol is a reflection of the direct action of supplemental β-agonist on net protein retention. Compared with Cr-YC treatments, ZIL increased dressing percentage (P < 0.01), and KPH (P=0.04). Compared with the control and Cr-YC treatments, increased carcass dressing percentage in ZIL treatment explained, on average a 79 % (0.235 kg d-1) of the increase in carcass adjusted ADG.

Treatment with Cr-YC did not affect growth performance or carcass characteristics, but compared with controls, Cr-YC supplementation tended to increase final BW (P=0.08), ADG (0.09), F:G (P = 0.08) and dietary NE (P = 0.06). Futhermore, level of supplemental Cr-YC increased (linear component, P ≤ 0.04) final BW, ADG, feed/gain, apparent dietary NEm, and decreased (linear component, P = 0.02) observed/expected DMI, fat thikness and KPH. Research has indicated that Cr-YC supplementation is beneficial to ruminants fed high-energy diets (Dawson *et al*. 1990, Cole *et al*. 1992 and Krehbiel *et al*. 2003) by enhancing growth performance, nitrogen balance, and nutrient digestion. However, other studies reported no benefits of dietary Cr-YC supplementation. According to the latter, Zinn *et al*. (1999) reported that intake of 28 g/hd d^{-1} of supplemental yeast did not influence ADG and feed efficiency during the first 56 d after their arrival at the feedlot. The basis for inconsistencies in growth performance responses to Cr-YC supplementation is not certain. Some research reported that the efficacy of Cr-YC supplementation depends, in part, on level of administration (Domínguez-Vara *et al*. 2009) and by the type of Cr-YC utilized (alone or in combination with minerals; Kellems *et al*. 1990). Chang and Mowat (1992) showed a marked increase in weight gain and feed efficiency of calves fed supplemental high-chromium yeast during the first 28 d after their arrival at the feedlot. In the same manner, Barajas *et al*. (2008) reported increases on ADG and lower KPH for steers received during 215 days a corn-based finishing diet supplemented with chromium-methionine (0.34 mg kg^{-1} of feed). Like the present study, a linear increases in final BW, ADG, feed efficiency, and linear reduction on fat carcass were observed in lambs fed

Table 3. Treatments effect on carcass characteristics in feedlot heifers

Item	Control	Level of yeast supplementation[1], g^{-1} $hd^{-1}d^{-1}$				SEM	P^2 value			Cr-YC level	
		Cr-YC10	Cr-YC20	Cr-YC30	ZIL		C vs. Cr-YC	C vs. ZIL	Cr-YC vs. ZIL	Lin	Qua
Observations	12.00	12.00	12.00	12.00							
HCW, kg	279.00	279.00	287.00	293.00	291.00	5.200	0.27	0.13	0.43	0.06	0.85
Dressing percentage	62.15	61.99	62.35	62.58	63.83	0.004	0.73	<0.01	<0.01	0.33	0.90
LM area, cm^2	79.50	79.83	79.27	81.29	84.46	1.979	0.78	0.06	0.08	0.61	0.59
Fat thickness, cm	0.85	0.86	0.81	0.77	0.77	0.023	0.11	0.02	0.21	0.02	0.81
KPH, %	3.33	3.42	3.08	2.79	2.67	0.182	0.26	0.02	0.04	0.02	0.93
Marbling score[3]	3.27	3.17	3.29	3.21	3.33	0.328	0.90	0.89	0.77	0.93	0.80

1 Source of yeast used were Ganadero-Plus and Beef -8 Ways (Biotecap®, Guadalajara, México) and were fed daily in 50:50 proportion of total dose offer during all experiment. ZIL= 6 mg/kg of feed of zilpaterol hydrochloride; Zilmax®, Intervet, México City, México. Zilpaterol was fed daily in feed for 30 d, drug withdrawn from the diet 3 d pre-harvest.

2 P = =Observed significance level for effect of treatments (C vs. Cr-YC=Control vs. averaged observed of all Yeast treatment, C vs. ZIL = control vs. zilpaterol supplementation, Cr-YC vs. ZIL= averaged observed of all Yeast treatment vs. zilaperol supplementation, and lineal and quadratic effect of level of yeast supplementation).

3 Coded: minimum slight = 3, minimum small = 4, etc.

finishing diet supplement with selenium-yeast (0 or 0.30 mg Se-yeast) and chromium-yeast (0, 0.25, or 0.35 mg Cr-yeast; Domínguez-Vara *et al*. 2009). In contrast, Swanson *et al*. (2000) reported no effect on ADG and gain efficiency in steers fed a corn silage-based diet supplemented with 0.10, 0.20, or 0.40 mg chromium from high-chromium yeast per kg of dry matter.

In practical terms, considering the results obtained here and based on the net energy value of steam-flaked corn of 2.32 Mcal/kg NEm (NRC,1996), compared with the control group, the energy advantage observed for treatments ZIL and Cr-YC was equivalent that the diets of these treatments containing 14.7 and 5.6% more SF-corn than control diet, respectively. Eliminating the safety alimentary aspect, in the final decision to use these additives in feedlot should be considering their economic cost

It is concluded that, zilpaterol supplementation increase growth performance in heifers as results of greater muscle accretion and for reduction of body fat. Chromium-enriched live yeast supplementation increase growth performance and dietary NE, without effect in carcass characteristics. The better responses were observed at yeast supplementation of 30 g d^{-1} that correspond to daily intakes of 1.65×10^{11} CFU and 15 mg of chromium d^{-1} (approximately 1.72 mg of Cr $kg^{-1}$of diet). However, considering the results obtained in previous studies and in present study, must be considered that further studies are needed to better define the effects of chromium-enriched live yeast supplementation on growth performance and carcass impact in finishing feedlot cattle.

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