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Influence of Ovariectomization (Spaying) and Feeding System on Performance and Carcass Characteristics of Implanted Beef Heifers

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Abstract: Thirty-two crossbreed heifers (246±10 kg) were used in 98 day feedlot growth performance trial to evaluate the effect of ovariectomization (intact vs. spayed) and feeding system (energy intake) on growth performance and carcass characteristics. Treatments were: Ovariectomized heifers fed a 2.16 Mcal NE_m kg^{-1} of diet throughout the 98 day trial (OVX- HHS); ovariectomized heifers fed a 1.72 Mcal NE_m kg^{-1} of diet during first 70 day and then switched to a 2.16 Mcal Ne_m kg^{-1} of diet for the remaining 28 day (OVX-LHS); intact heifers fed a 2.16 Mcal NE_m kg^{-1} of diet throughout the 98 day trial (INTC-HHS) and intact heifers fed a 1.72 Mcal Ne_m kg^{-1} of diet during first 70 day and then switched to 2.16 Mcal Ne_m kg^{-1} of diet for the remaining 28 day (INTC-LHS). There were no interactions ($p>0.20$) between spaying and feeding system on feedlot performance. Spaying did not affect DMI ($p>0.20$). However, it increased ($p<0.10$) ADG (12.3%), feed efficiency (6.3%), dietary NE_m (5%) and NE_g (6%). The increase in dietary NE due to spaying reflects a reduced maintenance energy requirement and/or leaner gain. Dry matter intake was lower (12.5%, $p<0.01$), but ADG ($p<0.10$) and feed efficiency (22.6%, $p<0.01$) were greater for HHS than for LHS feeding system. There were no treatment effects on carcass characteristics were detected. Spaying implanted beef heifers enhances feedlot growth-performance. This effect is not influenced by dietary energy density.

Key words: Heifers, spaying, performance, dry lot, feeding

INTRODUCTION

Weight gain and feed efficiency reductions caused by estrus activity in heifers results in substantial losses for stocker heifers and feedlot operations (Dunbar, 1986; Hill *et al*., 1988). Additionally, in Mexico, beef consumers demand meat with low fat content, so in Mexican feedlots, heifers have a lower purchase prices. Losses in efficiency are due in part to differences in behavior and body composition (Owens and Garner, 2000). On an equivalent live weight basis, heifers produce fatter carcass then steers (Klindt and Crouse, 1990; Choat *et al*., 2006). Spaying has been used to eliminate estrous cycles in heifers. But the associated loss of anabolic endogenous gonadal steroids (Horstman *et al*., 1982) may limit growth efficiency. In some cases, compared with implanted intact heifers, the use of steroidal implants has been demonstrated positive effects in performance of ovariectomized heifers (Adams *et al*., 1990). In an experiment conducted by Garber *et al*. (1990) observed that the implanted spaying heifers had greater ADG and were more efficient than implanted intact heifers only in finishing phase but not during growing phase. The latter indicated that energy density of diet may be a factor that affected the magnitude in the performance response of spayed implanted heifers.

The objective of this experiment was to investigate the interaction of feeding system (energy density of diets) on growth performance and carcass characteristics of spayed and intact implanted heifers.

MATERIALS AND METHODS

All procedures involving animals were made following approved Mexican Official Rules of humanitarian care of animals in: mobilization (NOM-051-ZOO-1995), transportation (NOM-024-ZOO-1995) and slaughter of animals (NOM-033-ZOO-1995). The experiment was carried out at the indoor experimental feedlot unit of the Veterinary Science Research Institute of the Autonomous University of Baja California, located in Mexicali City, in the state of Baja California, Mexico. Thirty-two crossbred heifers (approximately 20% zebú breeding with remainder represented by Hereford, Angus

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and Charolais breeds in various proportions) with an average initial weight of 246± 10 kg were used in 98 day feedlot growth performance trial to evaluate the effect of ovariectomization (intact vs. spayed) and feeding system (energy density) on growth performance and carcass characteristics. Before the start of the trial, all heifers were ear-tagged, dewormed (Ivomec®, Merck and Co. Inc., Whitehouse Station, NJ, USA.), vaccinated for bovine rhinotracheitis and parainfluenza$_3$ (TSV-2®, SmithKline Beecham, West Chester, PA), clostridials infections (Untrabac-7®, Pfizer Inc., Lincoln, NE, EUA.) and Mannheimia haemolytica (One Shot® SmithKline Beecham, West Chester, PA). Heifers were injected with 500,000 IU vitamin A (Aderovet®, Roussel, UCLAF, Francia) on arrival. Heifers were blocked by weight and randomly assigned within weight groupings to 16 slatted-floor indoor pens (2 heifers/pen). Pens provided 5.25 m^2 $heifer^{-1}$ and were equipped with automatic push paddle waterers and individual feed bunks (35 cm $heifer^{-1}$). Heifers were adapted to their pens (4 week) and to their experimental diets (2 week) before beginning the experiment. Treatments were: Ovariectomized heifers fed a 2.16 Mcal Ne_m kg^{-1} of diet throughout the 98 day trial (OVX-HHS); ovariectomized heifers fed a 1.72 Mcal Ne_m kg^{-1} of diet during first 70 day and then switched to a 2.16 Mcal Ne_m kg^{-1} of diet for the remaining 28 day (OVX-LHS); intact heifers fed a 2.16 Mcal Ne_m kg^{-1} of diet throughout the 98 day trial (INTC-HHS) and intact heifers fed a 1.72 Mcal Ne_m kg^{-1} of diet during first 70 day and then switched to a 2.16 Mcal Ne_m kg^{-1} of diet for the remaining 28 day (INTC-LHS). Upon initiation of the trial (day 1) heifers were implanted with a combination of 200 mg of trenbolone acetate and 20 mg of estradiol (Implemax-H® , Hoechst Roussel Vet, Mexico, D.F.) and 16 heifers were spayed (bilateral ovariectomy, via an incision through the left paralumbar fossa, with complete removal of the ovaries using an ovariotomoemasculator). All surgeries were performed under local anesthesia (10 mL of lidocaine-HCL, 2%) of and were realized by a certified large-animal-veterinarian. Experimental diets are shown in Table 1. Diets were prepared at approximately weekly intervals and heifers were fed twice daily (08:00 and 14:00 h) in a 30:70 proportion. Feed bunk was evaluated daily at 07:30 the refusal were weighed and tested to DM content. Heifers were weighed on days 1, 70 and 98 of the trial. Heifers were transported to commercial abattoir (Rastro TIF 154) located 3 km south from the experimental feedlot unit immediately after termination of the feeding phase. Hot carcass weights were obtained from all heifers at time of slaughter. After the carcasses were chilled for 48 h the following measurements were obtained: LM area, taken by direct grid reading of the eye muscle at the 12 th rib; subcutaneous fat over the eye muscle at the 12th rib taken at a location 3/4 the lateral length from the chine bone end; Kidney, Pelvic and Heart fat (KPH) as a percentage of carcass weight and marbling score (USDA, 1965). Energy Gain (EG) was calculated by the equation $EG = ADG^{1.095} * 0.068W^{.75}$, were EG is the daily energy deposited (Mcal/day) and W is the mean of body weight (kg) (NRC, 1984). Maintenance energy expended (EM) were calculated by the equations: $EM = 0.077\ W^{.75}$ (Lofgreen and Garret, 1968). From the derived estimates of energy required for maintenance and gain, the NE_m and NE_g values of the diet were obtained using the quadratic formula:

Table 1: Composition of experimental diets fed to heifers

Item	Diets: Low energy	High energy
Ingredient composition, % [a]		
Alfalfa hay	25.41	7.16
Sudangrass hay	20.37	5.14
Steam-rolled wheat	40.76	74.99
Cottonseed meal	2.07	---
Mineral mixture[b]	2.25	2.25
Dicalcium phosphate	0.56	---
Yellow grease	2.23	4.50
Cane molasses	6.35	5.96
Nutrient composition [c]		
NE maintenance, Mcal kg^{-1}	1.72	2.16
EN gain, Mcal kg^{-1}	1.11	1.49
Crude protein, %	13.15	12.98
NDF, %	29.0	14.0
Calcium, %	1.28	0.73
Phosphorus, %	0.41	0.36
Potassium, %	1.40	0.83

[a]DM basis, [b]Mineral mixture contained: Limestone, 61.20%; NaCl, 17.45%; Monensin, 1.10%, $FeSO_4$, 0.90%; $MnSO_4$, 0.23%; $CuSO_4$, 0.11% and $CoSO_4$, 0.012%, [c]Based on tabular NE values for feed ingredients (NRC, 1996)

$$X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

where, a = -0.877DMI, b = 0.877EM + 0.41DMI + EG and c = -0.41EM and $NE_g = 0.877NE_m - 0.41$. (Zinn and Shen, 1998).

In determining heifer performance, initial and final weights were reduced 4% account for digestive tract fill. The trial was analyzed as a randomized complete block design with a 2×2 factorial arrangement of treatments (Hicks, 1973). Pen means were used as experimental units.

RESULTS AND DISCUSSION

Spaying depressed feed intake of heifers for an average of 4 days (data not shown). Thereafter, feed intake was equal to or greater than the average intake for the 14 day period prior to surgery. The influence of

Table 2: Effects of two feeding system and ovariectomy on feedlot performance of implanted heifers [a]

	INTC		OVX		Management		Feeding system		
Item	LHS	HHS	LHS	HHS	INTC	OVX	LHS	HHS	SD
Days on test	98	98	98	98	98	98	98	98	
Pen replicates	4	4	4	4	8	8	8	8	-
Live weight, Kg [b]									
Initial	239.4	230.6	237.2	235.9	235.0	236.6	238.3	233.3	10.1
0-70 day.	333.5	338.8	326.8	348.6	336.2	337.5	330.1	343.7	20.8
0-98 day.	370.7	371.8	366.8	387.9	371.3	377.4	368.8	379.9	23.6
Weight gain, Kg day^{-1}									
0-70 day [c]	1.343	1.545	1.279	1.608	1.444	1.444	1.311	1.577	0.206
71-98 day [d]	1.330	1.178	1.431	1.403	1.254	1.417	1.381	1.291	0.124
0-98 day [g]	1.340	1.440	1.323	1.549	1.390	1.436	1.331	1.495	0.173
DM intake, Kg day^{-1}									
0-70 day [c]	8.138	6.586	7.416	6.632	7.362	7.021	7.773	6.609	0.774
71-98 day	8.787	7.544	8.184	8.067	8.165	8.125	8.484	7.806	0.850
0-98 day [c]	8.323	6.859	7.636	7.098	7.591	7.365	7.978	6.978	0.787
DM intake/gain									
0 - 70 day [e]	6.113	4.301	5.802	4.124	5.207	4.963	5.951	4.212	0.405
71 - 98 day [f]	6.625	6.269	5.714	5.771	6.447	5.742	6.169	6.020	0.404
0 - 98 day [e, h]	6.247	4.755	5.767	4.542	5.501	5.155	6.007	4.649	0.337

[a]INTC= Intact (no spayed), OVX= spayed, LHS= low-high energy feeding system, HHS = high-high energy feeding system, [b]Live weight were reduced 4% to account for digestive tract fill, [c]Feeding system effect, $p<0.05$, [d]Spaying effect, $p<0.05$, [e]Feeding system effect, $p<0.01$, [f]Spaying effect, $p<0.10$, [g]Feeding system effect, $p<0.10$, [h]Spaying effect, $p<0.05$

Table 3: Effects of two feeding system and ovariectimy on energetic efficiency of implated heifers[a]

					Main effects				
	INTC		OVX		Management		Feeding system		
Item	LHS	HHS	LHS	HHS	INTC	OVX	LHS	HHS	SD
Days on t98	98	98	98	8	98	98	_		
Pen replicates	4	4	4	4	8	8	8	8	--
Diet net energy Mcal kg^{-1} maintenance									
0-70 day [b]	1.80	2.32	1.86	2.40	2.06	2.13	1.83	2.36	0.11
71-98 day [c, d]	1.90	2.03	2.09	2.16	1.97	2.12	1.99	2.10	0.09
0-98 day [b, e]	1.83	2.22	1.93	2.31	2.03	2.12	1.88	2.26	0.09
Gain									
0-70 day [b]	1.15	1.61	1.21	1.67	1.38	1.44	1.18	1.64	0.09
71-98 day [c, d]	1.24	1.36	1.40	1.47	1.30	1.44	1.32	1.41	0.07
0-98 day [b, e]	1.18	1.52	1.27	1.59	1.35	1.43	1.23	1.56	0.08
Observed/expected diet NE maintenance									
0-70 day	1.03	1.06	1.07	1.10	1.05	1.08	1.05	1.08	0.05
71-98 day [c ,d]	0.87	0.93	0.96	0.99	0.90	0.97	0.91	0.96	0.04
0-98 day [e]	0.98	1.02	1.04	1.05	1.00	1.05	1.01	1.04	0.04
Gain									
0-70 day	1.04	1.07	1.11	1.11	1.05	1.10	1.06	1.09	0.07
71-98 day [c, d]	0.82	0.90	0.98	0.98	0.86	0.96	0.88	0.94	0.05
0-98 day [e]	0.97	1.01	1.06	1.06	0.99	1.05	1.00	1.04	0.06

[a]INTC= Intact (no spayed), OVX= spayed, LHS= low-high energy feeding system, HHS = high-high energy feeding system, [b]Feeding system effect, $p<0.01$, [c]Spaying effect, $p<0.01$, [d]Feeding System effect, $p<0.05$, [e] Spaying effect, $p<0.05$

spaying on 98 day growth performance response heifers and calculated diet NE of diet are shown in Table 2 and 3. There were no treatment interactions ($p>0.20$) among treatments. Spaying increased ($p<0.10$) average daily gain (12.3%), feed efficiency (6.3%), dietary NE_m (5%) and dietary NE_g (6%). In previous studies spaying has either or had no influence (Hamernick *et al*., 1985; Klindt and Crouse, 1990) or decreased performance efficiency (Dinusson *et al*., 1950; Horstman *et al*., 1982). Inconsistencies in responses have been attributed to age, weight, pen size, feeding system, slaughter weight and use of anabolic implants (Hamernick *et al*., 1985; Adams *et al*., 1990; Klindt and Crouse, 1990). In every case, where spaying did not enhance performance, or when spaying depressed performance, heifers were not implanted. In another hand, the performance response of spayed implanted heifers compared with intact implanted heifers are not consistent. For example, Adams *et al*. (1990) did not observe differences ($p>0.20$) in ADG when compared intact vs. spayed implanted heifers. However, one study showed the average daily gain response to implantation was fourfold greater ($p<0.07$) in spayed than in intact heifers (Garber *et al*., 1990). As indicated previously, the anabolic implant used in the present experiment was a combination of 200 mg of trembolone acetate and 20 mg of estradiol. There has been little research comparing implant programs in spayed heifers. Garber *et al*. (1990), reported that spayed heifers receiving an implant of estradiol/progesterone (Synovex S) gained significantly better ($p<0.05$) than heifers receiving an implant of estradiol/testosterone (Synovex H) in finishing periods. Additionally, Perino *et al*. (1995) reported an improved gain ($p<0.05$) in spayed heifers receiving estradiol or estradiol+trenbolone acetate, but not trenbolone acetate alone, over non-implanted, spayed heifers.

Similar to findings reported by Garber *et al*. (1990) no differences in ADG (1.34 vs. 1.323 kg) but better observed diet NE (8.5%, $p<0.10$) were detected among spayed *vs.* intact heifers in low-high energy system. While in HHS, spayed heifers tended to have a greater ADG (7%, $p>0.10$) than intact heifers. The average of NE_m of diet to low-high energy system used in the present experiment was slightly greater (1.83 vs. 1.61 and 1.72 Mcal kg^{-1}) than those used in previous studies (Garber *et al*., 1990; Geary *et al*., 2006) in which weight gains in spayed heifers did not differ of control heifers. Garber *et al*. (1990) observed positive responses in ADG to spaying-implanted heifers only in high energy diet program (>1.95 Mcal kg^{-1}) and thus, apparently, to obtain good responses in weight gain with spaying-implanted heifers, the energy density of the diet must be at least of 2.0 Mcal kg^{-1} of NE_m. The Spaying increased ($p<0.05$) the apparent NE value of the diet. This effect was likely due to a reduced maintenance energy requirement andor leaner gain. The latter can be confirmed by growth rate observed in the last 28 day of trial. Intact heifers decrease growth rate (kg d^{-1}) from 1.44 in the first 70 day to 1.25 in the last 28 day, while spayed heifers maintained ADG throughout the experiment (first 70 day = 1.44, last 28 day = 1.42 kg). Garber *et al* (1990) observed that heifers spayed and implanted tended to deposit more lean tissue and less fat in a 101 day growing-finishing trial. It well recognized that the lower efficiency (DMI/gain) observed in the last days of feeding in feedlots are result of changes in composition of gain (Old and Garret, 1987). Cattle in feedlot tended to gain more fat than protein in finishing phase (NRC, 2000) and fat are less dense (w/v) than muscle. The benefit in energetic due to spaying otherwise implanted heifers may be accounted for by increasing dietary NE 5.5%, or decreasing the maintenance coefficient 6.5%. Growth-performance efficiency of spayed implanted heifers was not influenced by diet energy density. As expected (Smith *et al*., 1977; Ferrell *et al*., 1978; Danner *et al*., 1980), DMI was lower (12.5%, $p<0.01$) and ADG (10.9%, $p<0.10$) and feed efficiency (22.6%, $p<0.05$) were greater for HHS than for LHS feeding system (Table 2). There was compensatory growth in LHS heifers in the last 28 day of finishing phase, but this was not sufficient to offset the lower gain observed in the first phase LHS.

Table 4: Effects of two feeding system and ovariectomy on carcass characteristics of implanted heifer [a]

	Management		Feeding system		
Item	INTC	OVX	LHS	HHS	S.D
Days on test	98	98	98	98	_
Pen replicates	8	8	8	8	_
Hot carcass weight, Kg.	29.2	236.2	228.0	236.6	9.8
Dress, %	61.7	62.6	62.0	62.3	1.9
Ribeye area, cm^2	68.5	71.6	69.762	70.367	1.2
KPH fat,%	2.719	2.813	2.782	2.750	0.2
Marbling, score[c]	4.000	3.625	3.812	3.812	1.258
Quality grade, score[d]	2.500	2.687	2.562	2.625	0.26
Yield grade	1.625	1.437	1.687	1.375	0.63

[a]INTC= Intact (no spayed), OVX= spayed, LHS= low-high energy feeding system, HHS = high-high energy feeding system, [b]Feeding system effect, $p<0.10$, [c]Mabling scores: Trace = 1, slight=2 , Small=3, Modest = 4, [d]Quality grade scores: stándar =1, Choice = 2, Select = 3

The influence of treatments on carcass characteristics is shown in Table 4. In agreement with findings of other studies, carcass traits were not affected by spaying (Cook *et al*., 2000; Geary *et al*., 2006). However, spay heifers tended ($p>0.10$) to shown a heavier HCW by an average of 7 kg and large LM area (4.4%). Choat *et al*. (2006) reported that in non-implanted heifers spaying reduced LM area and may coincide with reduced production of estrogen-related compounds, however, with anabolic implants this effect was overcome (Geary *et al*., 2006).

IMPLICATIONS

Spaying implanted beef heifers enhances feedlot growth-performance efficiency with no effects in carcass traits. This effect is not influenced by energy diet.

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