Comparison of Dairy Beef Genetics and Dietary Roughage Levels

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ABSTRACT

The objectives of these trials were to investigate the performance of Jersey steers in relation to Holsteins under current management practices when fed diets differing in energy density and subsequent effects on carcass characteristics. In experiment 1, twelve Jersey and 12 Holstein steers were offered dietary treatments with differing roughage levels. Roughage levels investigated on a dry matter basis were 55% reduced to 25% versus 25% followed by 12.5% (HIGH and LOW, respectively) with all animals receiving the same finishing diet containing 6.5% roughage. Holstein steers were heavier than Jerseys at the initiation of the trial (228 vs. 116 kg). A diet response was observed for gain efficiency during the first period in which LOW was greater than HIGH. Holstein steers had higher dry matter intakes and rates of gain than Jerseys. However, gain efficiency was better for Jersey steers during the first and last periods. Carcass traits were influenced by breed but not diet. Holsteins had heavier hot carcass weights, greater dressing percentages, more backfat, and larger longissimus muscle area, whereas marbling scores were similar to Jerseys. The increased efficiency of Jersey steers and significant reduction in carcass value due to light carcass weights suggested that Jersey steers should be fed to heavier live weights. Experiment 2 utilized 85 steers to investigate continuous feeding of a low-roughage, high-concentrate diet versus a phase-feeding strategy. Jersey ($n = 40$) and Holstein ($n = 45$) steers were assigned to a diet containing 20% corn silage on a dry matter basis (HEN) or a phase-feeding program (PHASE) in which corn silage was reduced from 60 to 40% followed by the same diet as HEN. Initial body weights were similar for dietary treatments but differed by breed. A diet response was observed for live weight at the end of the first and second period, first period average daily gain (ADG), overall ADG, and days on feed with HEN having higher ADG than PHASE and fewer days on feed. Breed affected all body

weight and gain variables with Holsteins being heavier and gaining more rapidly than Jersey steers. Jersey carcasses were lighter, had the highest percentage trim loss, least amount of backfat, and lowest numerical yield grade. Holstein steers had a greater propensity for gain, whereas the Jersey steers were equally or more efficient. These findings suggest that phase feeding Jersey steers higher-roughage diets has minimal effect on carcass traits.

Key words: feedlot, Jersey, Holstein, roughage

INTRODUCTION

The dairy industry produces a large number of bull calves annually. It is reported that approximately 8% of the slaughter beef cattle are Holsteins (Schaefer, 2005). There is a wide range in market value between the Holstein and Jersey breeds for these young bull calves and feeders with Jersey steers selling at a significant discount. In cycle I of the germplasm evaluation at the US Meat Animal Research Center, it was reported that Jersey-sired calves were slower growing compared with other beef breeds (Smith et al., 1976). Early research noted that British Friesian steers were more efficient than Jerseys while producing a 55% heavier carcass (Hind, 1978), and more recent research reported Holsteins having higher rates of gain than Jerseys (Barton et al., 1994). New Zealand researchers investigated several beef and dairy breeds with regards to beef production and observed that Friesian steers produced carcasses that were 39% heavier than Jerseys with higher dressing percentages and greater carcass bone weight than beef breeds (Barton and Pleasants, 1997). However, much of this research was conducted under grazing conditions, and little information is available regarding the performance and subsequent carcass characteristics of Jersey steers offered high grain rations under the management of today, which includes the use of growth-promoting implants.

In an effort to increase uniformity of beef produced from dairy genetics, many processors have implemented minimal and maximum carcass weight along with quality grade specifications, which are similar to beef grids with the exception that nearly all dairy beef grids include a minimum longissimus muscle area

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(LMA) or longissimus muscle width requirement. Further, most calf-fed Holstein steers fed on a forward contract are required to be fed a diet containing not more than 10% roughage for a minimum of 10 mo, and other processors have implemented height restrictions for cattle to reduce the number of extremely heavy carcasses. Therefore, the objectives of these trials were to compare Jersey and Holstein steers fed diets differing in roughage levels and the effect these feeding strategies have on carcass characteristics.

MATERIALS AND METHODS

These trials were approved by the Animal Care and Use Committee of the College of Agriculture and Life Sciences, University of Wisconsin.

Experiment 1

A pilot study was conducted to investigate 2 different phase-feeding strategies that provided similar metabolizable energy and protein allowable gain ratios. Twelve Jersey and 12 Holstein steers approximately 4 to 5 mo of age were received at the Arlington Beef Cattle Research and Teaching Center. This facility is a naturally ventilated, deepstack bedded confinement feeding facility. Holstein steers were sourced from a professional calf raiser and had been in a dry lot receiving a mixed grain and hay diet. Jersey steers had been managed on pasture with limited grain supplementation. To reduce the potential effect of previous management, animals were not started on trial until after being at the facility for approximately 70 d. Steers were vaccinated for infectious bovine rhinotracheitis, parainfluenza, bovine viral diarrhea, and bovine respiratory syncytial virus (Bovi-Shield, Pfizer Animal Health, New York, NY) and were treated for internal and external parasites with an ivermectin pour-on (Ivomec, Merial Ltd., Duluth, GA). Cattle were implanted with an estrogenic product on d 0, which corresponded to the day treatment diets were initially offered and again on d 152 (Synovex S, Fort Dodge Animal Health, Fort Dodge, IA). Steers were weighed on 2 consecutive days at the initiation and termination of the trial with single day weights taken intermittently. Steers were assigned to individual pens in an open front confinement barn with pen dimensions of 2 m × 3.5 m.

The Cornell Net Carbohydrate and Protein System computer rumen simulation model version 5.0 was utilized to evaluate 2- to 3-step feeding programs with one projected to allow 0.9 kg/d of gain and the other 1.4 kg/d during the first 2 phases with the last phase being a common finishing ration (Table 1). Diets were estimated to provide a metabolizable energy and metaboliz-

able protein allowable gain ratio slightly above 1.0. The percentage of roughage in the diet was calculated assuming corn silage contained 50% grain and 50% roughage. Total mixed rations were delivered to bunks once daily near 0800 h. Feed was mixed in a reel-type type mixer, and feed was weighed for each pen using a hanging spring scale (Model 600, Hanson, Shubuta, MS). Bunks were managed to provide near ad libitum intake with a goal of having no feed refusals present before feed delivery the next morning. Feed intakes were summarized for each period. Gain efficiency (GE) was calculated as kilograms of live weight gain divided by kilograms of feed DM consumed.

Two Jersey and 2 Holstein steers (one from each diet treatment) that visually appeared to have the highest level of body fat were harvested on d 234. Steers were evaluated based on fullness of the brisket and fat deposition over the ribs and around the tailhead. This early harvest was conducted to determine the end point for Jersey steers, because the Jersey steers did not appear to be depositing subcutaneous fat as they approached projected mature weights. This harvest confirmed that Jersey steers had obtained adequate intramuscular fat to obtain USDA quality grades of choice with minimal backfat deposition while accumulating significant quantities of visceral fat. These observations were used in deciding when to harvest the remaining steers. The remaining 20 steers were on trial for 250 d, at which time they were harvested at a commercial packing plant. Hot carcass and trimmed weights were recorded after slaughter with backfat thickness at the 13th costae, LMA, marbling score, and official USDA quality grade collected following a 48-h chill. Carcass measurements were collected by trained individuals from the University of Wisconsin.

Experiment 2

A second experiment was conducted to examine the performance and subsequent carcass characteristics of Jersey and Holstein steers fed either continuously a 10% roughage diet or a decreasing roughage strategy that utilized higher roughage levels early in the feeding period. Due to the slower growth rate of Jerseys observed in the first trial, the starting point of Jersey and Holstein steers was staggered, with Jerseys starting on trial before Holsteins to allow a similar harvest end point in time. Two dairies agreed to raise Jersey bull calves from birth to 4 mo of age. Jersey bull calves were born within a 35-d period. Upon arrival at the Arlington Beef Nutrition facilities on June 28, 2004, free choice hay and a calf starter were offered the first week after arrival. Corn silage was introduced the day of arrival, and the steers were transitioned to the experimental

Table 1. Diet composition offered to Jersey and Holstein steers during experiment 1¹

Ingredient, % DM	Phase 1		Phase 2		Finish
	HIGH	LOW	HIGH	LOW	
Whole HM corn ²	19.5	36.5	49.3	64.3	78.7
Alfalfa haylage	40	—	10	—	—
Corn silage	30	50	30	25	12
Supplement	10.5	13.5	10.7	10.7	9.3
	% of supplement DM				
Soybean meal	52.0	29.3	18.6	61.5	32.2
Wheat middlings	25.3	21.2	—	—	—
Ground corn	—	—	61.8	18.3	21.4
Urea	8.6	—	2.8	2.9	10.7
Bloodmeal	—	18.3	—	—	—
Fishmeal	—	18.3	—	—	—
Calcium carbonate	5.9	5.0	9.0	10.0	19.3
Iodized salt	2.2	1.8	2.3	2.5	2.7
Dynamate	—	—	—	—	2.1
Potassium chloride	—	—	—	—	1.1
Rumensin 6.5% ³	1.7	1.4	1.6	1.9	2.1
Tylan 2.75% ³	1.7	1.4	1.6	1.9	2.1
Vitamin ADE premix ³	0.4	0.3	0.4	0.4	0.5
Trace mineral premix ³	0.4	0.3	0.4	0.4	0.5
Vitamin E premix ³	0.4	0.3	0.4	0.4	—
Choice white grease	1.4	1.4	0.9	0.9	5.3
Nutrient composition					
DM, %	56	56	60	62	75
CP, ⁴ %	17.4	14.3	11.5	12.9	13.4
NE _M , ⁴ Mcal/kg	1.75	2.15	2.13	2.25	2.19
NE _G , ⁴ Mcal/kg	0.96	1.28	1.26	1.35	1.31
Roughage level, ⁵ %	55	25	25	12.5	6

¹HIGH = high-roughage phase-feeding protocol; LOW = low-roughage continuous-feeding protocol; phase 1 = d 0 to 90; phase 2 = d 91 to 173; finish = d 174 to harvest on d 250.

²HM = high-moisture.

³Rumensin 6.5% = Rumensin 6.5 g/100 g of finely ground corn; Tylan 2.75% = 2.75 g/100 g of finely ground corn; trace mineral premix = 25% calcium, 1% iron, 4% manganese, 6% zinc, 200 mg/kg of cobalt, 6,000 mg/kg of copper, 1,000 mg/kg of iodine, and 200 mg/kg of selenium; vitamin E premix = 9,080 IU/kg; vitamin ADE = 544,800 IU/kg of vitamin A, 181,600 IU/kg of vitamin D, and 726 IU of vitamin E/kg.

⁴Calculated using Cornell Net Carbohydrate and Protein System computer software version 5.0 rumen simulation model.

⁵Calculated using corn silage as having 50% roughage and haylage as 100% roughage equivalent.

diets over a period of time as described below. Jersey bull calves were castrated using a burdizzo clamp and dehorned with the use of local anesthesia by the attending veterinarian approximately 2 wk after arrival.

A total of 40 Jersey steers were utilized in the project and started on trial after a 43-d transition period. This transition period was utilized to reduce the effect of castration and previous nutritional plane on subsequent performance. Holstein steers were obtained from a privately owned calf-raising facility. Low birth weight, approximately 39 kg, Holstein bull calves born within a 2-wk window were purchased at 4 mo of age and arrived at the research facilities on August 6, 2004. After a transition period of 41 d, Holstein steers (n = 48) were started on trial. Steers were assigned to 1 of 8 group pens per breed (16 pens total) resulting in 5 to 6 steers per pen. Treatments were randomly assigned to pens within breed, resulting in 4 replicates per dietary

treatment. All steers appeared healthy at the initiation of the study, and steers were treated as necessary for respiratory illness based on recommendations by the attending veterinarian.

Diets fed, DM basis, are shown in Table 2. Steers were assigned to either a high-energy diet, which included 10% roughage the entire feeding period (HEN) or a phase-feeding strategy that included 30%, 20%, and 10% roughage (PHASE). The roughage source used was corn silage, and it was assumed that corn silage was 50% grain and 50% roughage. Period 1 was 84 and 76 d in length for Jersey and Holsteins, respectively. Holstein steers spent fewer days on the period 1 diet as a result of the staggered on-trial dates and the desire to synchronize future diet changes with Jersey steers and subsequent weight collections. Period 2 was 84 d in length for both dairy breeds. A common finishing diet was fed the last period for either 124 or 174 d and

Table 2. Composition of diets fed during experiment 2 to Jersey, Holstein, and Twiner steers¹

Ingredient, % DM	Period 1		Period 2		Finish
	PHASE	HEN	PHASE	HEN	
Corn silage	60	20	40	20	20
HM corn ²	20.6	60.3	43.6	60.3	64.6
Roasted soybeans	12	12	9	12	8
Supplement	7.4	7.7	7.4	7.7	7.4
	% of supplement DM				
Dried distillers grains			65.4		
Calcium carbonate			25.7		
Urea			4.0		
Iodized salt			2.65		
Trace mineral premix ³			0.6		
Vitamin ADE premix ³			0.6		
Vitamin E premix ³			0.6		
Rumensin 80			0.25		
Tylan 40			0.20		
Nutrient composition					
DM, %	50.5	65	54	63.5	64.5
NDF, %	30.6	24.3	25.3	20.3	19.0
Calculated CP, %	14.3	14.8	13.6	14.8	13.6
NE _M , ⁴ Mcal/kg	1.87	2.12	1.97	2.12	2.11
NE _G , ⁴ Mcal/kg	1.23	1.45	1.33	1.45	1.44
Roughage ⁵	30	10	20	10	10

¹HEN = high-energy diet with 10% roughage equivalent fed continuously; PHASE = phase-feeding protocol with decreasing levels of roughage; period 1 = d 0 to 76 for Holstein and 0 to 84 d for Jerseys; period 2 = d 77 to 160 for Holsteins or d 85 to 168 for Jerseys; finish = d 161 or 169 to harvest for Holstein and Jersey steers, respectively.

²HM = high moisture.

³Trace mineral premix = 25% calcium, 1% iron, 4% manganese, 6% zinc, 200 mg/kg of cobalt, 6,000 mg/kg of copper, 1,000 mg/kg of iodine, and 200 mg/kg of selenium; vitamin E premix = 9,080 IU/kg; vitamin ADE = 544,800 IU/kg of vitamin A, 181,600 IU/kg of vitamin D, and 726 IU of vitamin E/kg.

⁴Calculated using Cornell Net Carbohydrate and Protein System computer software version 5.0 rumen simulation model.

⁵Roughage calculated assuming corn silage contained 50% roughage and 50% grain and 0% roughage for other diet components.

96 or 146 d for Jersey and Holstein steers, respectively. Varying feeding lengths reflect differences in slaughter dates as well as the additional DOF due to slower rates of gain for the Jersey steers, which was partially offset by starting the Jersey steers on trial about 30 d before the Holsteins to allow for harvest within a similar interval.

Dairy steers were implanted with a zeranol implant (Ralgro, Schering-Plough, Kenilworth, NJ) on d 0. Jersey and Holstein steers were reimplanted twice with a trenbolone acetate combination implant containing 100 mg of trenbolone acetate and 14 mg of estradiol benzoate (Synovex Choice, Fort Dodge Animal Health). Jerseys were reimplanted on d 84 and 168, whereas Holsteins were reimplanted on d 76 and 160. One Holstein steer was removed from the test due to a retained testicle and a second due to liver abscesses (determined postslaughter). Target slaughter points were set to minimize carcass weight discounts. From the previous trial, it was noted that the target end point for the Jersey steers would need to be greater than 454 kg of BW

using the observed 55% dressing percentage to avoid light carcass discounts that were assessed to carcasses lighter than 250 kg. Steers were slaughtered on 2 different dates at a commercial facility. The majority of the Holstein steers were harvested on the first date along with a few Jersey steers. Cattle were weighed before being fed and then loaded for transportation to the packing plant. Carcass traits as described above were measured following a 48-h chill.

Periodic bunk samples of the diet treatments were collected. Samples were stored frozen until processing. Samples were dried in a forced-air oven at 60°C for 48 h before particle reduction through a 1-mm screen using a cross-beater mill (Retsch SM 100, F. Kurt Retsch GmbH and Co. K. G., Haan, Germany). Samples were later analyzed for absolute DM placing a 1-g sample in a 100°C oven overnight. Sequential NDF and ADF were determined for feed samples using α -amylase and Na₂SO₃ (Ankom²⁰⁰ Fiber Analyzer, Ankom Technology Corporation, Fairport, NY).

Table 3. Main effects of differing metabolizable energy levels and breed for Jersey and Holstein steers from Experiment 1

Item	Diet ¹		Breed		SEM	<i>P</i> -value	
	HIGH	LOW	Holstein	Jersey		Diet	Breed
Period 1							
Initial BW, kg	170	164	218	116	5.3	0.46	<0.001
DMI, kg/d	5.74	5.67	6.9	4.6	0.18	0.81	<0.001
ADG, kg	1.15	1.23	1.38	1.01	0.04	0.20	<0.001
GE ²	0.20	0.22	0.20	0.22	0.006	0.07	0.03
Period 2							
Initial BW, kg	275	277	344	208	7.3	0.87	<0.001
DMI, kg/d	7.07	6.78	8.3	5.6	0.22	0.37	<0.001
ADG, kg	1.16	1.16	1.39	0.93	0.06	0.97	<0.001
GE	0.16	0.17	0.17	0.17	0.008	0.56	0.90
Finish							
Initial BW, kg	371	373	459	285	8.1	0.90	<0.001
DMI, kg/d	8.97	8.68	10.5	7.2	0.32	0.53	<0.001
ADG, kg	1.41	1.38	1.52	1.27	0.07	0.78	0.02
GE	0.16	0.16	0.14	0.18	0.008	0.87	0.005
Final BW, kg	478	478	574	382	9.4	0.97	<0.001

¹HIGH = high-roughage phase-feeding protocol; LOW = low-roughage continuous-feeding protocol.

²GE = gain efficiency; kilograms of live weight gain per kilogram of DMI.

Statistical Analysis

Data were analyzed using the MIXED procedure of SAS 9.0 (SAS Inst. Inc., Cary, NC). In experiment 1, animal served as the experimental unit with breed, dietary treatment, and dietary treatment $\times$ breed interactions included in the model as fixed effects. Data from experiment 2 were analyzed with pen being the experimental unit. Performance responses to dietary treatment for dairy steers were analyzed using a mixed model with diet treatment, breed, and interaction of dietary treatment $\times$ breed included in the model as fixed effects with period included as a random effect. Carcass traits were analyzed as described above for experiment 1, whereas slaughter data were analyzed with harvest date included as a random variable with data weighted based on frequency for experiment 2. Least squares means were generated using the PDIF statement and were considered different at the $P < 0.05$ level.

RESULTS

Diet Response for Holstein vs. Jersey

There were no breed $\times$ dietary treatment interactions observed in experiment 1, and only the main effects for feeding strategy and breed are reported (Table 3). Altering the level of metabolizable energy in diets did not ($P > 0.05$) alter ADG or DMI for Jersey or Holstein steers during any of the 3 periods (Table 1). Gain efficiency tended to be improved ($P = 0.07$) for LOW steers compared with HIGH during the first period only.

A breed effect was observed in experiment 1 (Table 3). Jersey steers were lighter than Holsteins at the

initiation of the trial, and this difference increased over the course of the trial. Intake increased with DOF, and BW increased for both Jersey and Holstein steers. Holstein steers had higher DMI and greater ADG ($P < 0.05$) compared with Jerseys during all periods. Holsteins had on average 35% greater ADG than Jersey steers. However, GE was observed to be slightly better for Jerseys during the first and third periods ($P < 0.05$).

Feeding protocol did not influence most carcass traits for Holstein and Jersey steers in experiment 1 (Table 4). Carcasses from LOW did have greater ($P < 0.05$) LMA compared with HIGH. However, breed differences were observed between the dairy steers. Holstein carcasses were heavier and had greater dressing percentage and LMA with a tendency ($P = 0.06$) to have more backfat compared with Jerseys. Marbling scores did not differ by breed type ($P = 0.19$). Jersey carcasses had 33% greater trim loss percentage than Holsteins ($P < 0.05$), which was attributed primarily to visceral fat differences, because visual inspection of the carcasses did not reveal carcass trim differences.

At the start of experiment 2, initial weights were not different for the dietary treatments, but a breed difference was observed (Table 5). Feeding strategy and breed of dairy steer affected performance. During the first period when PHASE cattle were receiving 60% corn silage diets, a diet and breed effect was noted with ADG being higher ($P < 0.001$) for HEN vs. PHASE and Holstein steers having greater ADG than Jerseys. A diet $\times$ breed interaction ($P < 0.01$) was also observed for DMI during period 1 following the same pattern as BW with Jersey HEN and Holstein HEN steers consuming 9 and 16% more DM than PHASE steers. When

Table 4. Carcass traits for Holstein and Jersey steers offered 2 levels of metabolizable energy during experiment 1

Item ²	Diet ¹		Breed		SEM	P-value	
	HIGH	LOW	Holstein	Jersey		Diet	Breed
HCWT, kg	269	271	333	208	5.3	0.74	<0.001
Dressing, %	56.1	56.7	58.0	54.8	0.30	0.18	<0.001
Trim loss, %	4.8	5.2	4.3	5.7	0.37	0.54	0.01
LMA, cm ²	65.0	69.3	75.2	59.0	1.07	0.01	<0.001
Backfat thickness, cm	0.42	0.47	0.54	0.35	0.07	0.60	0.06
Marbling score	551	590	578	563	20.1	0.19	0.60
YG	2.3	2.1	2.4	2.1	0.13	0.39	0.08

¹HIGH = high-roughage phase-feeding protocol; LOW = low-roughage continuously fed protocol.

²HCWT = hot carcass weight; dressing = hot carcass weight divided by live weight; trim loss = trimmed carcass weight divided by hot carcass weight; LMA = longissimus muscle area; marbling score where 400 = slight 0, 500 = small 0, etc.; YG = USDA official yield grades as called by inspector.

DMI was expressed as a percentage of BW, a diet and breed effect was observed in period 1 with HEN steers having greater intakes ($P < 0.001$) than PHASE and Holsteins consuming more DM than Jerseys ($P < 0.001$).

During period 2, Holstein steers had ADG nearly 43% greater than Jersey steers ($P < 0.001$), whereas diet did not affect ADG ($P = 0.14$). Differences in performance during period 2 resulted in a diet $\times$ breed interaction for BW at the end of period 2 with HEN Holstein $>$ PHASE Holstein $>$ HEN Jersey $>$ PHASE Jersey ($P <$

0.01). As in period 1, diet and breed responses were observed ($P < 0.001$) for DMI during period 2 with HEN being greater than PHASE and Holsteins consuming more feed than Jerseys. Yet feeding strategy did not influence intake ($P = 0.74$) when expressed as a percentage of BW during period 2 with only a breed effect observed with Holsteins consuming more per unit of BW than Jerseys ($P < 0.001$).

When all steers were switched to the common finishing diet, Holsteins continued to have 35% greater ADG

Table 5. Effect of varying dietary energy level at different stages on Holstein and Jersey steer performance in experiment 2

Item	Holstein		Jersey		SEM	P-value		
	HEN ¹	PHASE ¹	HEN	PHASE		Diet	Breed	Diet $\times$ breed
Initial BW, kg	179	174	118	117	3.7	0.27	<0.001	0.43
Period 1								
BW, kg	305	270	224	205	6.4	<0.001	<0.001	0.12
ADG, kg	1.65	1.26	1.26	1.04	0.063	<0.001	<0.001	0.08
DMI, kg/d	7.3	6.3	4.7	4.3	0.13	<0.001	<0.001	<0.01
DMI, % BW	3.0	2.8	2.8	2.7	0.06	<0.01	<0.001	0.21
GE ²	0.23	0.20	0.27	0.24	0.010	<0.01	<0.001	0.97
Period 2								
BW, kg	442	394	313	298	6.4	<0.001	<0.001	<0.01
ADG, kg	1.64	1.47	1.06	1.11	0.054	0.14	<0.001	0.02
DMI, kg/d	9.5	8.4	5.7	5.2	0.21	<0.001	<0.001	0.06
DMI, % BW	2.5	2.5	2.1	2.1	0.09	0.74	<0.001	0.83
GE	0.17	0.18	0.19	0.21	0.003	<0.001	<0.001	<0.001
Finish								
ADG, kg	1.73	1.86	1.18	1.15	0.044	0.11	<0.001	0.03
DMI, kg/d	11.4	12.2	7.2	7.2	0.27	0.21	<0.001	0.18
DMI, % BW	2.2	2.5	1.8	1.8	0.09	0.02	<0.001	0.05
GE	0.15	0.15	0.16	0.16	0.008	0.79	0.16	0.80
Final BW, kg	614	594	487	486	7.3	0.06	<0.001	0.08
Overall ADG, kg	1.68	1.57	1.17	1.13	0.022	<0.001	<0.001	0.03
DMI trial, kg/d	9.6	9.3	6.2	6.0	0.19	0.06	<0.001	0.71
DMI trial, % BW	2.4	2.4	2.1	2.0	0.07	0.45	<0.001	0.50
GE trial	0.18	0.17	0.19	0.19	0.004	0.42	<0.001	0.33
Days on feed	260	269	317	327	5.2	0.02	<0.001	0.91

¹HEN = high-energy diet with 10% roughage equivalent fed continuously; PHASE = phase-feeding protocol with decreasing levels of roughage.

²GE = gain efficiency; kilograms of live weight gain per kilogram of DMI.

Table 6. Carcass traits for dairy steers receiving differing dietary energy levels during experiment 2

Item ¹	Holstein		Jersey		SEM	P-value		
	HEN ²	PHASE ²	HEN	PHASE		Diet	Breed	Diet × breed
HCWT, kg	362	340	273	276	5.3	0.02	<0.001	<0.01
Dressing, %	58.9	57.4	56.1	56.8	0.64	0.31	<0.001	0.02
Trim, %	5.6	4.9	7.3	7.4	0.35	0.26	<0.001	0.10
LMA, cm ²	79.8	77.2	73.9	75.9	2.39	0.85	0.04	0.17
Marbling score	651	572	619	566	32.0	<0.01	0.42	0.55
Backfat thickness, cm	0.69	0.59	0.41	0.30	0.058	0.01	<0.001	0.93

¹HCWT = hot carcass weight; dressing = hot carcass weight divided by live weight; trim = trimmed carcass weight divided by hot carcass weight times 100; LMA = longissimus muscle area; marbling score, where 400 = slight 0, 500 = small 0, etc.

²HEN = high-energy diet with 10% roughage equivalent fed continuously; PHASE = phase-feeding protocol with decreasing levels of roughage.

than Jersey steers ($P < 0.001$) during this period. No diet response was observed during the finishing period. Holstein steers consumed approximately 64% more DM than Jersey steers during the finishing period ($P < 0.001$). A diet × breed interaction ($P = 0.05$) for DMI as a percentage of BW was observed during this time frame with Holstein PHASE > Holstein HEN > Jersey HEN = Jersey PHASE. Final weights obtained before harvest were affected by diet ($P < 0.05$) for Holsteins only with HEN being heavier than PHASE Holsteins and both Jersey groups. Final weight tended to differ by diet ($P = 0.06$) and a breed effect was observed with Holstein steers being about 105 kg heavier than Jerseys ($P < 0.001$). Days on feed was greater for PHASE than HEN ($P = 0.02$). Jersey steers were on feed approximately 60 d longer to reach the target end point than Holstein steers ($P < 0.001$).

When GE was investigated, it was noted HEN steers were more efficient ($P < 0.05$) than PHASE during period 1 and 2, whereas no differences were observed in GE during the finishing period or overall ($P = 0.79$ and 0.42 , respectively). A breed effect was also observed for GE during period 1, 2, and overall with Jersey steers being more efficient than Holsteins ($P < 0.001$). A diet × breed interaction ($P < 0.001$) was noted in period 2 with Jersey PHASE > Jersey HEN > Holstein HEN = Holstein PHASE. During period 3, GE was similar for both breeds ($P = 0.16$).

Carcass traits for dairy steers harvested in experiment 2 are reported in Table 6. Holsteins had heavier hot carcass weight than Jerseys, and HEN produced heavier carcasses than PHASE ($P < 0.05$). A breed × diet interaction for dressing percentage was observed with HEN Holstein carcasses yielding more than other carcasses with PHASE Holstein and Jersey PHASE not differing and being intermediate. Jersey HEN had the lowest dressing percentage and nearly 3 percentage units lower than HEN Holsteins. Percentage trim loss was observed to be much higher ($P < 0.05$) for the Jersey

carcasses compared with the Holsteins with the trim representing mostly the weight of the kidneys and visceral fat, because visual assessment of outer carcass trim was minimal and not treatment-dependent. Longissimus muscle area did not differ by diet ($P = 0.85$). Jersey carcasses had LMA nearly 5% smaller than Holsteins, yet when expressed on a per-unit-of-carcass-weight basis (data not shown), the inverse is true. Feeding strategy affected fat deposition, with marbling scores for HEN having more intramuscular fat than PHASE ($P < 0.01$) and greater backfat thickness between the 12th and 13th costae ($P = 0.01$). Breed did not alter marbling scores ($P = 0.42$), but Holstein carcasses did have greater backfat than did Jerseys ($P < 0.001$).

DISCUSSION

Jersey steers were found to gain slower than Holsteins and yet were equal to or had improved efficiencies of gain. Bond et al. (1972) reported gains for Jerseys 38% lower on average than Holsteins from 180 d of age to slaughter. When Holstein, Milking Shorthorn, and Jersey steers were fed either a finishing diet with 25% hay, a hay-based diet, or hay followed by a short period of time on the finishing diet from 180 d of age to slaughter, Jersey steers fed hay diets had ADG only 6% lower than those on the 25% hay finishing diet, whereas Holstein steers grew 20% slower on a hay-based ration (Bond et al., 1972). This is interpreted as Jersey steers having a lower genetic propensity for gain than Holsteins, suggesting the ability to utilize fewer calories to produce beef from Jersey steers. Baker et al. (1991) reported Jersey steers had a higher relative growth coefficient of empty BW to live weight and suggested it was due to differences in maturing rates between Holstein and Jersey steers. Others have reported slower rates of gain for Jersey or Jersey-sired calves compared

with Holstein or other beef breeds (Smith et al., 1976; Barton et al., 1994; Burke et al., 1998).

Efficiency of gain comparisons can be investigated using a variety of methods, which may involve live weight, lean, fat, and others. When comparing Jersey and Holstein steers, Hind (1978) reported that Holsteins were more efficient with respect to live weight gain than Jersey steers, whereas the differences were not as pronounced when expressed as efficiency of lean tissue accretion, which was in contrast to previous research (Bond et al., 1972). However, no differences in efficiency estimates were observed between Holstein and Jersey cows, with F1 crossbreds being more efficient (Schwager-Suter et al., 2001). Improved efficiency of live weight gain for Holstein-sired calves compared with Jersey-sired calves has been illustrated by others as well (Bond et al., 1972; Burke et al., 1998). The findings reported herein do not agree with the previous literature, and it is apparent that additional investigation is warranted to determine factors affecting efficiency differences between Jersey and Holstein steers.

Jersey steers deposit fat in the various depot sites differently than Holsteins. This was inferred by higher trim loss observed for Jerseys in this experiment while having equal or greater amounts of intramuscular fat along with less subcutaneous backfat. Greater kidney, pelvic, and heart fat has been observed previously for Jersey steers and bulls compared with Holsteins (Talamantes et al., 1986; Barton et al., 1994, 1998). When carcasses had similar amounts of subcutaneous fat, Jersey carcasses were reported to have greater kidney, pelvic and heart fat, and intramuscular fat than Holsteins (Butler-Hogg and Wood, 1982), supporting the current findings. Thus, visual assessment of the degree of finish for Jersey steers does not adequately reflect total body fat and USDA quality grade, resulting in a tendency for overfeeding Jersey steers. This is important with respect to efficiency of production as it relates to optimal harvest endpoints and subsequent profitability for finishing Jersey steers.

The interaction between dairy breed and dietary treatment should be considered when formulating diets to achieve targeted performance levels. In this trial, Jersey steers did not respond to increasing diet energy density to the same extent as Holstein steers. Holstein steers exhibited a compensatory gain-like response under the phase-feeding strategy, and this was not observed in the Jerseys. Daily gains were observed to be higher for Holstein steers after being transitioned to a common finishing diet that had previously been phase-fed diets containing varying levels of roughage versus those consuming the same high-concentrate finishing diet for greater than 300 d (Schoonmaker et al., 2004), agreeing with these findings. Bond et al. (1972) ob-

served increased efficiency for all breed types when on a lower plane of nutrition from birth to 180 d of age than those consuming a greater amount of energy. Energetic efficiency was reported to be greater for Holstein steers consuming diets containing corn silage compared with alfalfa haylage at similar proportions even though metabolizable energy intake was greater for haylage-containing diets (Comerford et al., 1992). Dietary differences in carcasses grading percentage choice in the current work agrees with previous research for Holstein steers (Comerford et al., 1992; Schoonmaker et al., 2004).

CONCLUSIONS

These data provide information for Jersey steer performance and carcass traits compared with Holsteins under current management practices. Jersey steers exhibit slower rates of gain than Holstein steers, which needs to be accounted for in feeder prices to offset the increased costs associated with more DOF. Phase feeding resulted in slightly lower cumulative ADG for Holstein steers and more DOF. However, this management strategy is an option that producers with a large amount of corn silage or other high-quality forage can utilize to finish dairy steers with minimal effects on carcass traits when harvested at similar live weights. The diets used in the phase-feeding strategy produced desirable carcasses and rates of gain that were acceptable, supporting a phase-feeding management strategy as a viable alternative to continuous feeding of a low-roughage diet for 300 plus days for Jersey steers.

REFERENCES

- Baker, J. F., W. L. Bryson, J. O. Sanders, P. F. Dahm, T. C. Cartwright, W. C. Ellis, and C. R. Long. 1991. Characterization of relative growth of empty body and carcass components for bulls from a five-breed diallel. *J. Anim. Sci.* 69:3167–3176.
- Barton, R. A., J. L. Donaldson, C. F. Jones, and H. J. Clifford. 1994. Comparison of Friesian, Friesian-Jersey-cross, and Jersey steers in beef production. *N. Z. J. Agric. Res.* 37:51–58.
- Barton, R. A., and A. B. Pleasants. 1997. Comparison of the carcass characteristics of steers of different breeds and pre-weaning environments slaughtered at 30 months of age. *N. Z. J. Agric. Res.* 40:57–68.
- Bond, J., N. W. Hooven Jr., E. J. Warick, R. L. Hiner, and G. V. Richardson. 1972. Influence of breed and plane of nutrition on performance of dairy, dual-purpose and beef steers. II. From 180 days of age to slaughter. *J. Anim. Sci.* 34:1046–1053.
- Burke, J. L., P. W. Purchas, and S. T. Morris. 1998. A comparison of growth, carcass, and meat characteristics of Jersey- and Friesian-cross heifers in a once-bred heifer system of beef production. *N. Z. J. Agric. Res.* 41:91–99.
- Butler-Hogg, B. W., and J. D. Wood. 1982. The partitioning of body fat in British Friesian and Jersey steers. *Anim. Prod.* 35:253–262.
- Comerford, J. W., R. B. House, H. W. Harpster, W. R. Henning, and J. B. Cooper. 1992. Effects of forage and protein source on feedlot performance and carcass traits of Holstein and crossbred beef steers. *J. Anim. Sci.* 70:1022–1031.

- Hind, E. 1978. Efficiency of lean meat production by British Friesian and Jersey steers. *Anim. Prod.* 27:181–189.
- Schaefer, D. M. 2005. Yield and quality of Holstein beef. Pages 185–197 in *Proc. Managing and Marketing Quality Holstein Steers*, Rochester, MN. H. Chester-Jones, ed. Waseca, MN.
- Schoonmaker, J. P., F. L. Fluharty, and S. C. Loerch. 2004. Effect of source and amount of energy and rate of growth in the growing phase on adipocyte cellularity and lipogenic enzyme activity in the intramuscular and subcutaneous fat depots of Holstein steers. *J. Anim. Sci.* 82:137–148.
- Schwager-Suter, R., C. Stricker, D. Erdin, and N. Kunzi. 2001. Net energy efficiencies of Holstein, Jersey and Holstein-Jersey F1 crosses. *Anim. Sci.* 72:335–342.
- Smith, G. M., D. B. Laster, L. V. Cundiff, and K. E. Gregory. 1976. Characterization of biological types of cattle. II. Postweaning growth and feed efficiency of steers. *J. Anim. Sci.* 43:37–47.
- Talamantes, M. A., C. R. Long, G. C. Smith, T. G. Jenkins, W. C. Ellis, and T. C. Cartwright. 1986. Characterization of cattle of a five-breed diallel. VI. Fat deposition patterns of serially slaughtered bulls. *J. Anim. Sci.* 62:1259–1266.