BRIEF COMMUNICATION: Liveweight, body composition, carcass traits and meat quality of artificially reared milk-fed Friesian-Jersey crossbred heifer and bull calves

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Abstract

Novel approaches are required by the dairy industry to identify productive endpoints for surplus calves beyond 4-day-old bobby calves. The objective of this study was to characterise carcass weight, body composition, and meat quality attributes of ~11-week-old milk-fed dairy bull and heifer calves. Mixed-sex Friesian-Jersey crossbred dairy calves (n=73) were artificially reared. Calves were weighed at birth and slaughter. Carcass weight, heart girth, and the weight of selected organs and muscles were recorded. Meat quality parameters were evaluated including muscle pH, colour, and intramuscular fat percentage (IMF). Bulls had greater average daily gain (P=0.003), slaughter weight (P=0.007), and carcass weight (P=0.022) than heifers. IMF % (P=0.038), redness (P=0.009), yellowness (P=0.041), and chroma (P=0.011) were greater in heifers than bulls, while pH, lightness, and hue angle were similar (P>0.05). This study provides new information to inform the potential utilisation of milk-fed calves for novel meat products.

Keywords: Cattle; growth, meat quality, milk-fed veal

Introduction

The Dairy Tomorrow Strategy (DairyNZ et al. 2017) outlined a vision and strategy for the future of the New Zealand dairy sector involving a commitment to a high level of animal care that provides all animals a life worth living. Practices such as processing very young animals (e.g., 4-day-old bobby calves) are being challenged by increasing consumers' interest in the ethical standards of food systems, and concerns around the processing of young animals are expected to continue to increase (Bolton & Von Keyserlingk 2021). However, rearing all the surplus calves is a major challenge for the industry as there is not sufficient land available without displacing other land uses.

At least 74% of New Zealand beef produced originates in the dairy industry (Edwards et al. 2021). On average, it is estimated at the herd level that 28% of calves are retained as replacements, 12% are reared on-farm for beef, 15% are sold for beef rearing, 35% are sold to process as "4-day-old bobby calves", 5% are euthanised and 4% are born dead or died (Edwards et al. 2021). Identification of new opportunities to utilise the large number of non-replacement calves from the New Zealand dairy cow industry and eliminate the processing of bobby calves is important to maintain the social licence to operate.

Current initiatives to explore alternative meat value chains for these calves have focused on rosé veal from 8- to 12-month-old animals. Our prior research in dairy sheep lambs indicates that a 3-week-old milk-fed meat product has similar meat quality characteristics and intramuscular fat content to ~3-4 month-old grass-fed lambs and is highly desirable by consumers (Pavan et al. 2022). Similar data for milk-fed veal calves from New Zealand pasture-based rearing systems, to support exploration of potential novel meat product alternatives for this class of animal are not available.

The objective of this study was to generate baseline information on carcass weight, body composition (muscle, fat, organs), carcass yield and meat quality characteristics in 10-12 week-old milk-fed dairy calves reared in a pasture-based management system.

Materials and methods

All animal manipulations in this study were approved by the AgResearch Animal Ethics Committee (Approval number AEC808). The animals used in this study were sourced from another experiment evaluating a nutritional supplement ("treatment") where there was no effect of treatment on calf parameters. Seventy-three mixed-sex (35 heifers and 38 bulls) crossbred calves were born in Spring 2023 to mixed-age Kiwicross dams (Friesian sire) calved indoors on straw. The calves were removed from the dams within 10 hours of birth and allocated to one of 9 indoor mixed sex rearing pens (3 pens/treatment) bedded with straw on the farm of origin (Dairy 4, Massey University, Tennent Drive, Palmerston North, NZ). All calves were offered three 2L feeds of warm pooled gold colostrum (Brix >24) from their dams over the first 36 hours post-collection. Calves were then offered warm transition milk (2 × 2L per calf per day) for the next 9 feeds and then transitioned over 2 days onto a warm calf milk replacer (CMR, AnCalf, NZAgBiz, NZ) mixed at 150 g/L according to the manufacuter's recommendations. At approximately 10 days of age, all calves were transported for ~30 minutes to the AgResearch Aorangi Research Farm (Lockwood Road, Palmerston North, NZ). Calves were randomly allocated to pens (~12 calves/pen) and fed 2 × 2L of warm CMR per day (600 g DM/d mixed at 150 g/L) for ~10 days in a north-facing 3-sided pole shed bedded with wood chips. Calves were then transitioned outdoors over 5 days by offering free indoor-outdoor access to ~~a~~ pasture and offered 2 × 2.5L CMR per day (788 g DM/d mixed at 175 g/L) for 5 days (~25/group – "cohort"). At ~25 days of age, calves were then moved in their groups to one of three sheltered pasture paddocks and offered 2 × 2L of warm CMR per day (~800g DM/d; mixed at 200 g/L) for 9 days. Calves were transitioned to once-a-day feeding (final volume of 4.5L/hd/d) over 5 days (1049 g DM/d; mixed at 233 g/L). Concentration of CMR was increased over time to achieve target dry matter intake with a lower milk volume to stimulate solid feed intake. Calves were maintained at this feeding level until the end of the study. All calves were fed using compartmentalised feeders (Stallion Plastics, Palmerston North, NZ) and individually monitored to ensure each calf received its allocated feed. Calves were offered *ad libitum* grain-based calf starter (20% protein pellets, Seales Winslow, NZ) from arrival at Aorangi Farm.

All calves were weighed at birth and at the end of the study to calculate average daily gain (ADG). All calves received a trace element injection (Multimin®, Virbac, Hamilton, NZ) on arrival to Aorangi Farm (~10 days of age) and a clostridial vaccine (Ultravac 7:1, Zoetis, Auckland, NZ) at ~5.5 weeks of age and a booster 4 weeks later. No calves were disbudded or castrated.

All calves were fed at noon on the day prior to humane killing. Calves in each "cohort" were humanely killed by captive bolt stunning, pithing, and exsanguination at a similar age. Weight of the femur, tongue, selected organs (heart, liver, kidney, spleen, thymus) and perirenal fat were recorded. The carcasses were hung and chilled overnight at 4°C. On the following day, the cold carcass weight was recorded. Temperature and pH were measured at 24 hours. The *M. Longissimus thoracis et lumborum* (LTL) and *M. Semitendinosus* were removed from the right side of the carcass, weighed, and subsamples collected for meat quality assessments as previously described (Pavan et al. 2022). Instrumental colour (Minolta Chroma Meter) was measured after 30 min bloom time on the exposed LTL surface. The intramuscular fat (IMF) percentage of loin samples (LTL) was measured based on total fatty acids detected in the muscles using a direct trans-methylation method (Agnew et al. 2019).

Data was analysed using the SAS System and a mixed model including sex, treatment, and their interaction as fixed effects and pen nested within treatment, animal nested within pen and treatment, and breed of dam as random effects. Least squares means were compared using Tukey's test. Data are presented as means and standard errors of the mean.

Results and discussion

No calves died during this study and one calf was treated for an infection at the ear tag site. No other animal health issues were evident. Bull calves had greater ADG, slaughter weight, carcass weight and yield and lower perirenal fat mass compared to heifers, while no other differences in body composition were observed (Table 1). The higher growth rate of bull compared to heifer calves is consistent with previous observations in Angus and crossbred calves pre-weaning (Woods et al., 1990) but contrasts those in Friesian calves (McCoard et al. 2019). Reasons for the differences between studies are unclear but may be related to the feeding system used or breed-specific effects.

Meat from heifers showed higher colour values for redness, yellowness, and chroma indicating a more vibrant meat colour compared with bulls. This may be due to differences in muscle fibre characteristics and fat content between heifers and bulls (Kučević et al., 2019). In this study, heifers had greater IMF percentages (0.78 vs 0.69%, P=0.038) compared to bulls, which is consistent with observations in older animals (Hughes et al. 2019; Kučević et al., 2019; Tan and Jiang 2024). There were no differences in muscle pH or colour lightness and hue angle between heifers and bulls.

This study provides baseline information on growth, carcass and meat quality attributes of heifer and bull milk-fed dairy animals, to support future studies to determine the potential of this class of animals for novel milk-fed veal products from pasture-based management systems with low chemical inputs and minimal painful procedures. Future work on consumer/society, welfare guidelines for their production and opportunities to improve eating quality through nutrition would provide further insights into the potential opportunities for a novel meat product from this class of animal to contribute to new opportunities for the large number of non-replacement calves from the dairy cow industry.

Table 1. The effect of calf sex on live weight, average daily gain, body composition and meat quality attributes of FxJ dairy calves slaughtered at ~11 weeks of age.

Parameter	**Heifer (n=35)**	**Bull (n=38)**	**P-value**
Average daily gain (g/d)	798 ± 14	850 ± 13	**0.003**
Slaughter weight (kg)	101.9 ± 1.5	105.5 ± 1.4	**0.045**
Slaughter age (d)	80.3 ± 0.9	78.3 ± 0.9	**0.003**
Body composition:			
Carcass weight (kg)	48.2 ± 1.0	51.1 ± 0.9	**0.013**
Carcass yield	47.3 ± 0.4	48.5 ± 0.4	**0.048**
Heart girth at slaughter (cm)	107.8 ± 0.6	108.7 ± 0.6	0.234
Femur weight (g)	1.13 ± 0.02	1.06 ± 0.02	0.063
Heart weight (g)	627 ± 13	643 ± 12	0.379
Liver weight (kg)	2.20 ± 0.05	2.30 ± 0.05	0.121
Kidney (x2) weights (g)	482 ± 13	474 ± 12	0.585
Perirenal fat (g)	463 ± 31	396 ± 29	**0.038**
Spleen (g)	544 ± 69	564 ± 66	0.063
Thymus (g)	432 ± 14	454 ± 13	0.245
Tongue (g)	303 ± 8	308 ± 7	0.467
M. Longissimus thoracis lumborum weight (g)	1150 ± 28	1179 ± 26	0.393
M. Semitendinosus weight (g)	431 ± 12	440 ± 12	0.427
Meat quality attributes (*M. Longissimus thoracis*):			
pH at 24 hrs postmortem	5.7±0.03	5.7±0.03	0.591
L* (lightness)	44.2±0.53	44.1±0.52	0.839
a* (redness)	12.3±0.24	11.5±0.23	**0.009**
b* (yellowness)	8.7±0.20	8.1±0.19	**0.041**
Chroma	15.1±0.28	14.1±0.27	**0.011**
Hue angle	34.8±0.62	35.4±0.59	0.419
Intramuscular fat %	0.78±0.031	0.69±0.030	**0.038**

Acknowledgements

The authors sincerely thank the Massey University Dairy 4, AgResearch Aorangi Research Farm and Ulyatt Reid Large Animal Facility staff for the management and care of the animals during the study and technical support. This study was funded by the AgResearch Strategic Science Investment Fund (A25765 and A27235) and Ballance AgriNutrients and the Ministry of Primary Industries "Future Ready Farms – Together, creating a lower emissions Future" Sustainable Farming Futures Fund program.

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