Growth rate and carcass characteristics of Simmental- and Angus-sired steers born to Angus and Angus-cross-dairy cows

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Abstract

Traditionally, British breeds have been the main source of beef produced in New Zealand. Recently the use of dairy breeds has increased. This experiment evaluates the growth rate and carcass characteristics of steers (n=64) born to straightbred Angus (AA), Angus-cross-Holstein Friesian (AF), Angus-cross-Jersey (AJ) or Angus-cross-Kiwicross (AK) dams, and sired by Angus (A) or Simmental (S) bulls. This created eight crossbred treatments: A-AA (n=10), A-AF (n=9), A-AJ (n=10), A-AK (n=5), S-AA (n=11), S-AF (n=3), S-AJ (n=11) and S-AK (n=5). Live weight between 329 days of age and slaughter, and ultrasound-derived and slaughter-day carcass characteristics were measured. At 400 and 600 days of age, respectively, Simmental-sired steers were 22 kg and 37 kg heavier than Angus-sired steers ($P<0.05$). All steers had a similar intramuscular fat percentage ($P>0.05$). Simmental-sired steers had greater eye-muscle area than Angus-sired steers ($P<0.05$). Simmental-sired steers had heavier and longer carcasses, and greater dressing-out percentages than Angus-sired steers ($P<0.05$). Simmental sires produced fast-growing progeny with heavier carcasses than Angus sires for all dam lines. Angus-cross-dairy cows produced steer progeny with similar carcass characteristics to those from Angus cows bred with beef bulls.

Keywords: beef-cross-dairy steers; growth rate; carcass characteristics; Simmental; Angus

Introduction

Traditionally, beef production in New Zealand has consisted of meat supplied from British beef breeds (Angus and Hereford), but it has recently become more common to use animals from the dairy industry in breeding systems (Beef + Lamb NZ 2013). Beef-cross-dairy breeding cows within a terminal-sire system offer advantages in terms of productivity and efficiency (Law et al. 2013). Dairy-breed cows have greater milk production than traditional beef breeds; this may result in heavier calves at weaning which reach their target slaughter weight faster compared with lighter calves at weaning (Sawyer 1993).

The use of beef-cross-dairy cows within the beef breeding herd takes advantage of the milk production abilities of the dairy breeds and can increase the efficiency of beef production through progeny with hybrid vigour and potentially greater growth rates (Morris et al. 1993; Hickson et al. 2012). There has been an increase in the use of Kiwicross cows within the dairy industry but there is little evidence to date as to how the progeny of Kiwicross cows perform as beef breeding cows (Hickson et al. 2012; Law et al. 2013). In addition, total number of dairy cows has increased, increasing the number of dairy-crossbred calves available to the beef industry.

The New Zealand beef grading and payment schedule focuses on three main aspects; fatness, muscularity, and carcass weight. Dairy-breed carcasses have a different distribution of fat on the carcass (less subcutaneous fat) and different muscle distribution (poorer conformation) than traditional beef breeds; such differences are perceived to be somewhat less desirable to the farmer, as lower carcass weights result in lower meat yield and lower returns to the farmer (Barton et al. 1994).

Identification of the most appropriate sire for beef-cross-dairy cows, particularly those with a Jersey component, is important, as this may assist the New Zealand beef-finishing farming system to perform more efficiently. The objective of this experiment was to compare growth and carcass characteristics of steers from various dam genotypes from 329 days of age to slaughter and determine if Simmental-sired progeny performed better than Angus-sired progeny.

Materials and methods

Animals and experiment design

Sixty-four steers born in 2011 were used in this experiment. The steers were born to second-calving, three-year-old dams that were: straightbred Angus (AA), Angus-cross-Holstein Friesian (AF), Angus-cross-Jersey (AJ) or Angus-cross-Kiwicross (AK).

The steers were sired by either Angus (A, n=4) or Simmental (S, n=4) bulls (Law et al. 2013). The mean 600-day weight estimated breeding value (EBV) was +94 kg for the Angus bulls and +29 for the Simmental bulls. This placed the Angus bulls at the 55-60th percentile, and the Simmental bulls at the 45th percentile for 2011-born calves of the respective breeds. Accuracy of the EBV for 600-day weight ranged from 62-68%.

The steers in the experiment were categorised into eight crossbred genotypes: A-AA (n=10), A-AF (n=9), A-AJ (n=10), A-AK (n=5), S-AA (n=11), S-AF (n=3), S-AJ (n=11) and S-AK (n=5). Steers were reared on their dams until 156 days of age, as detailed by Law et al. (2013). After weaning, the steers were grazed in one herd until 20th June 2012 for a 60-day winter feeding treatment experiment.

This experiment began when the steers were moved to Riverside Farm (10 km north of Masterton) at the conclusion of the winter feeding treatment experiment. During the experimental period (from an average age of 329 days until slaughter at 720 days of age) the steers were grazed in one herd and managed according to commercial farm practices. The steers were fed on a perennial-ryegrass-based pasture. They experienced severe drought conditions with minimal pasture growth from approximately 423 days of age (December 2012) to 573 days of age (April 2013), during which time they were fed perennial-ryegrass-based baleage as a major part of the daily ration.

Steers were slaughtered when they reached the target live weight of 550 kg. Pre-slaughter live weight was recorded on-farm prior to transport by commercial carrier to the abattoir. The steers were slaughtered and dressed following standard commercial abattoir practices (Land Meats New Zealand Ltd situated in Wanganui), approximately 24 hours after removal from pasture. The carcasses did not undergo electrical stimulation.

Live animal measurements

Unfasted live weight was recorded at monthly intervals throughout the experiment. Carcass traits were measured using ultrasound at 366 (12 months), 555 (18 months), 661 (22 months) days of age. Ultrasound measurements were undertaken by a Breedplan-accredited commercial operator. Measurements included eye-muscle area (EMA; area of longissimus muscle on a transverse plane), intramuscular fat in the longissimus (IMF; as a percentage), rump fat at the P8 site (P8; subcutaneous fat measured at the junction of the biceps femoris and gluteus medius between the ischium and ilium, and parallel to the vertebral column) and rib-fat depth (depth of the subcutaneous fat over the longissimus). Ultrasound measurements associated with the longissimus muscle were taken between the 12^{th} and 13^{th} rib.

Slaughter and carcass measurements

Measurements taken at the time of slaughter included hot carcass weight, carcass length (Purchas & Morris 2007), and dressing-out percentage, which was calculated as hot carcass weight as a percentage of the on-farm pre-slaughter live weight.

A grade was given to the carcasses based on subcutaneous fat cover over the 12^{th} or 13^{th} rib and muscling according to the New Zealand commercial beef grading scheme (NZMPB 1996). Carcass classification was undertaken by commercial carcass graders (employees of Land Meat NZ Limited). Colour of the subcutaneous fat was subjectively assessed on the carcasses after skinning using eight colour standards as a reference with a score of 1 the whitest and 8 the yellowest (Burke et al. 1998).

Calculations and statistical analysis

Data was analysed using SAS version 9.3 (SAS institute Inc., 2012, Cary, NC, USA). The variables carcass weight, carcass length and pre-slaughter live weight were analysed using a general linear model that considered the fixed effect of dam crossbreed and sire breed. Two-way interactions were considered. These models also included age of steer as a covariate. The 400-day and 600-day age-adjusted weight for each steer was derived by using the average daily gain to interpolate between the two live weights that occurred before and after the day the steer turned 400 or 600 days old. These were analysed using a general linear model that considered the fixed effect of dam crossbreed and sire breed and their interaction.

The variables liveweight gain, live weight, EMA, IMF, P8 and rib-fat depth were all analysed using mixed models allowing for repeated measures. The random effect of animal was included in the model for analysis of repeated measures. All models included the fixed effects of age, day of measurement, dam crossbreed and sire breed. Fat colour and carcass grade showed little variation among the steer genotypes so these were not analysed. Instead, descriptive statistics are presented for these variables.

Results

Growth characteristics

Simmental-sired steers were heavier (P<0.05) than the Angus-sired steers throughout the experiment. Simmental-sired steers were approximately 22 kg and 37 kg heavier (P<0.05) than Angus-sired steers at 400 days and 600 days of age respectively (Table 1). Steers from AF and AK dams were heavier (P<0.05) than steers from AA and AJ dams at any given age. The mean liveweight gain was similar (P>0.05) for all steers irrespective of dam crossbreed or sire breed.

Table 1 Least squares means ± SEM for 400-day and 600-day age-adjusted weight, average daily liveweight gain (ADG) and pre-slaughter live weight of steers from different sire breeds (Angus & Simmental) and dam genotypes (straightbred Angus AA, Angus x Friesian AF, Angus x Jersey AJ, Angus x Kiwicross AK)

		400-day wt (kg)	600-day wt (kg)	Pre-slaughter LWT (kg)	ADG (kg/day)
Dam breed	n				
AA	21	407±6.4	480±7.2	554.6±9.6	0.65±0.03
AF	12	428±8.7	497±9.7	578.0±12.9	0.62±0.04
AJ	21	406±6.4	477±7.2	557.0±9.7	0.63±0.03
AK	10	425±9.3	495±10.4	575.1±13.8	0.64±0.04
P-value		0.097	0.246	0.36	0.916
Sire breed					
Angus	34	397±5.2^{a}	473±5.8^{a}	554.2±7.7^{a}	0.61±0.02
Simmental	30	436±5.7^{b}	502±6.4^{b}	578.3±8.5^{b}	0.65±0.03
P-value		<0.001	0.001	0.038	0.324

ab = values within column for each effect without superscripts in common differ at the P<0.05 level.

Ultrasound measurements of carcass characteristics

Steers had similar (P>0.05) IMF irrespective of sire or dam genotype (Table 2). Simmental-sired steers and A-AF steers all had similar (P>0.05) amounts of EMA, which was greater (P<0.05) than that for A-AA, A-AJ and A-AK steers (Table 2). Use of an Angus sire compared with a Simmental sire increased P8 for steers born to AF and AJ dams, but not for those born to AA or AK dams (P<0.05).

The A-AK steers had the least (P<0.05) rib fat in the Angus-sired group. The S-AJ steers had the least (P<0.05) rib fat in the Simmental-sired group. S-AK steers had greater (P<0.05) rib fat than the S-AA steers in the Simmental-sired group.

Carcass characteristics

Hot carcass weight was similar (P>0.05) for all steers from all dam genotypes. Steers from the AF and AK dams had longer (P<0.05) carcasses than steers from AA dams. The dressing-out percentage of steers from AA dams was greater (P<0.05) than for steers from AJ dams (Table 3).

Simmental-sired steers had greater (P<0.05) hot carcass weight, carcass length and dressing-out percentage than Angus-sired steers (Table 3). All steers had the same visually assessed fat colour (graded as 3 on a 1-8 scale) at the time of slaughter. Most steers graded P2 at slaughter. There were seven steers (one from each genotype except A-AF) that graded L2.

Table 2 Least squares means ± SEM for ultrasound measurements of intramuscular fat (IMF), eye-muscle area (EMA), rump fat at the P8 site (P8) and rib fat measured over the *m. longissimus* between the 12th and 13th rib (rib fat) for dam x sire groups of steers (dam genotypes: straightbred Angus AA, Angus x Friesian AF, Angus x Jersey AJ, Angus x Kiwicross AK), taken at 366 (12 months), 555 (18 months) and 661 (22 months) days of age and presented as a mean of the three measures

Sire	Angus				Simmental				P-values		
Dam	AA	AF	AJ	AK	AA	AF	AJ	AK	Sire	Dam	Sire x Dam
n	10	9	10	5	11	3	11	5			
IMF (%)	3.38±0.25^{ab}	3.79±0.27^{b}	3.14±0.28^{ab}	3.26±0.38^{ab}	3.70±0.24^{ab}	2.82±0.45^{a}	3.16±0.25^{a}	3.92±0.39^{b}	0.978	0.34	0.125
EMA (cm^2)	61.39±0.94^{a}	67.23±1.04^{b}	61.93±1.05^{a}	60.71±1.44^{a}	68.69±0.92^{b}	69.23±1.73^{b}	67.51±0.96^{b}	69.96±1.50^{b}	<0.001	0.032	0.061
P8 (mm)	3.61±0.17^{bc}	3.83±0.19^{c}	3.61±0.19^{bc}	3.09±0.26^{ab}	3.34±0.17^{b}	3.16±0.31^{ab}	2.90±0.17^{a}	3.70±0.27^{bc}	0.178	0.555	0.024
Rib fat (mm)	2.94±0.13^{cd}	3.14±0.14^{d}	3.02±0.14^{cd}	2.44±0.19^{ab}	2.55±0.12^{b}	2.61±0.23^{bc}	2.19±0.13^{a}	2.94±0.20^{bcd}	0.03	0.377	0.002

abcd = values within row without superscripts in common differ at the P<0.05 level

Table 3 Least squares means ± SEM for hot carcass weight (Hot CC wt), carcass length (CC length) and dressing-out percentage (DO%) of steers from different sire breeds (Angus & Simmental) and dam genotypes (straightbred Angus AA, Angus x Friesian AF, Angus x Jersey AJ, Angus x Kiwicross AK)

		Hot CC wt (kg)	CC length (mm)	DO%
Dam	***n***			
AA	21	290.2±5.0	2218±10.8^{a}	52.3±0.3^{b}
AF	12	298.8±6.7	2265±14.5^{b}	51.8±0.4^{ab}
AJ	21	282.6±5.0	2248±11.0^{ab}	50.7±0.3^{a}
AK	10	294.7±7.1	2269±15.5^{b}	51.2±0.4^{ab}
P-value		0.24	0.02	0.002
Sire				
Angus	34	281.7±4.0^{a}	2234±8.7^{a}	50.8±0.2^{a}
Simmental	30	301.5±4.4^{b}	2266±9.6^{b}	52.2±0.2^{b}
P-value		0.001	0.018	0.001

ab = values within column for each effect without superscripts in common differ at the P<0.05 level

Discussion

Growth characteristics

Simmental-sired steers were significantly heavier than Angus-sired steers throughout the experiment with the difference in live weight increasing as the age of the steers increased, resulting in a greater live weight of Simmental-sired steers for 400-day and 600-day age-adjusted weights and also pre-slaughter live weight compared with Angus-sired steers (Table 1). This is likely a result of the larger mature size of the Simmental breed driving a faster growth rate (Dymnicki 2001; Everitt 1979; Deland 1991).

Steers from AF and AK dams had 25% and 12.5% of their genes from the Friesian breed respectively; this may explain the higher live weight of those steers compared with steers from AJ and AA dams of which are earlier maturing and smaller size breeds (Vance et al. 2011). Angus-sired dairy-cross and Simmental-sired steers should have had more potential for growth compared with straightbred Angus steers due to the increased heterosis, with A-AF, A-AJ and A-AK steers having 50% individual heterosis and Simmental-sired steers having 100% individual heterosis. Another study (Burke et al. 1998) reported greater (37 kg) final live weights for Friesian-cross progeny compared with Jersey-cross progeny. Higher growth of 1.97 kg/day vs 1.57 kg/day for Simmental and Angus progeny respectively have been reported (Alberti et al. 2008).

Live animal measurements of carcass characteristics by ultrasound

Late-maturing breeds (Simmental) deposit more muscle and less fat compared with dairy breeds (Friesian and Jersey) and early maturing breeds (Angus) at the same age, (Williams et al. 2009). Therefore, it was expected that Angus-sired steers would have a greater amount of IMF, rib fat and P8 fat compared with Simmental-sired steers. There was no effect of breed of sire or dam, or their interaction on the IMF of the steers. These animals experienced drought conditions as rising two-year-olds causing some feed restrictions, potentially resulting in the steers' inability to show their full genetic potential expression of fat deposition (Alberti et al. 2008).

A longer carcass allows for greater muscle deposition, resulting in Simmental-sired steers and A-AF steers with a similar EMA, which was greater than the EMA of A-AA, A-AJ and A-AK steers as a result of the physically larger sized Simmental and Friesian breeds of those particular steers (Table 2). This is in agreement with the results from Schreurs et al. (2014) who reported results for EMA of 70.7 cm^2, 73.0 cm^2, 67.8 cm^2 and 73.6 cm^2 of steers born to AA, AF, AK and AJ dams respectively.

Carcass characteristics measured after slaughter

The greater hot carcass weight, carcass length and dressing-out percentage of Simmental-sired steers compared with Angus-sired steers was consistent with a previous study (Alberti et al. 2008) and is likely explained by the probable larger size and weight of the Simmental-sired steers at slaughter (Table 3).

The AF and AK dams appeared to contribute to the longer carcass of the steers compared with steers from AA dams due to the genetically larger frame size of the Friesian breed compared with the shorter, blockier Angus and Jersey breeds (Table 3). Other authors (Burke et al. 1998; Morris 2006; Purchas & Morris 2007) have also reported longer carcasses in Friesian compared with Jersey steers. Absence of heterosis for A-AA steers may also have contributed to the lower growth rates and smaller carcasses (Burke et al. 1998).

Conclusion

Simmental-sired steers had greater live weight and a larger carcass at slaughter with an adequate level of carcass fat. In comparison, Angus-sired steers had lower growth rates, which resulted in a smaller carcass at slaughter with only a slightly greater level of carcass fat that did not alter carcass grade, than the Simmental-sired steers. Larger carcasses, of the same grade result in the farmer receiving a greater monetary return as farmers are paid on a dollar per kg carcass weight basis in most New Zealand slaughter plants.

Overall, AF and AK dams produced progeny with greater live weight and level of carcass fat compared with AA and AJ dams. Steers from AJ dams were smaller, slower growing animals with a lower level of fat compared with steers from AA, AF and AK dams, therefore, in terms of growth and level of carcass fat of their progeny it is not recommended to use AJ dams in the beef breeding system. Simmental bulls appeared to be a superior sire for all of these dam genotypes to produce progeny for meat production purposes as second-calving cows.

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References

Alberti P, Panea B, Sanudo C, Olleta J, Ripoll G, Ertbjerg P, Christensen M 2008. Liveweight, body size and carcass characteristics of young bulls of fifteen European breeds. Livestock Science 114:19-30.

Barton RA, Donaldson JL, Barnes FR, Jones CF, Clifford HJ 1994. Comparison of Friesian, Friesian-Jersey cross, and Jersey steers in Beef production. New Zealand Journal of Agricultural Research 37: 51-58.

Beef + Lamb 2013. Beef + Lamb New Zealand Economic Service: New Season Outlook 2013-14. Wellington: Beef + Lamb New Zealand.

Burke J, Purchas R, Morris S 1998. A comparison of growth, carcass and meat characteristics of Jersey- and Friesian-cross heifers in a once-bred heifer system of beef production. New Zealand Journal of Agricultural Research 41: 91-99.

Deland MP 1991. Lifetime productivity of crossbred cows.1. Experimental-design, growth and carcass characteristics of progeny. Animal Production Science 31: 285-292.

Dymnicki E 2001. Growth rate, feed intake and feed conversion in fattening bulls of main beef breeds kept in Poland. Animal Science Paper and Reports 19: 231-239.

Everitt GC 1979. Growth and carcass composition of straight-bred and beef-cross Friesian steers in several environments. Animal Science 23: 11-20.

Hickson RE, Kenyon PR, Lopez-Villalobos N, Laven RL, Fraser KR, Balcomb CC, Morris ST 2012. The most efficient beef cow. Proceedings of the Society of Sheep and Beef Cattle Veterinarians of the New Zealand Veterinary Association 4.22.1-4.22.7.

Law NL, Hickson RE, Lopez-Villalobos N, Kenyon PR, Morris ST 2013. Efficiency of beef breeding cows that vary in live weight and milking potential. Proceedings of the New Zealand Society of Animal Production 73: 11-16.

Morris C, Baker R, Carter A, Cullen N, Amyes N, Hickey S 1993. Evaluation of two-breed composites alongside Angus or Hereford controls for growth, reproduction, maternal and carcass traits. New Zealand Journal of Agricultural Research 36: 327-340.

Morris S 2006. Cross breeding in beef cattle herds. Retrieved from New Zealand Beef Statisitics: http://www.beef.org.nz/research/breeding/breed_xbreed.asp

NZMPB 1996. New Zealand meat: Guide to beef carcass classification. (Pamphlet). New Zealand Meat Producers Board, Wellington.

Purchas R, Morris S 2007. A comparison of carcass characteristics and meat quality for Angus, Hereford x Friesian, and Jersey x Friesian steers. Proceedings of the New Zealand Society of Animal Production 67: 18-22.

SAS 9.3, 2012. Statistical Analysis System. SAS Institute Inc, Cary, NC, USA

Sawyer GJ 1993. Time of joining affects the performance of young angus and Angus x Friesian cattle in the south west of Western Australia .2. Calf productivity and its relationship with milk production and reproduction in 1st calvers. Australian Journal of Experimental Agriculture 523-529.

Schreurs NM, Hickson RE, Coleman LW, Kenyon PR, Martin NP, Morris ST 2014. Brief Communication: Quality of meat from steers born to beef-cross-dairy cows and sired by Hereford bulls. Proceedings of the New Zealand Society of Animal Production 74: 229-232.

Vance ER, Ferris CP, Elliot CT, McGettrick SA, Kilpatrick DJ 2011. Food intake, milk production, and tissue changes of Holstein-Friesian and Jersey x Friesian dairy cows within a medium-input grazing system and a high-input confinement system. Journal of Dairy Science 95: 1527-1544.

Williams J, Aguilar I, Rekaya R, Bertrand J 2009. Estimation of breed and heterosis for growth and carcass traits in cattle using published crossbreeding studies. Journal of Animal Science 88: 460-466.