
VOLUME 62 2002

A comparison of carcass characteristics and meat quality for Angus, Hereford x Friesian, and Jersey x Friesian steers

R.W. PURCHAS and S.T. MORRIS[1]

Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand.

ABSTRACT

The aims of the two trials described here were to compare carcass characteristics and meat quality of Jersey-Friesian cross steers (Je x Fr) with Hereford-Friesian cross steers (He x Fr) and purebred Angus steers. Trial 1, which compared rising 3-year-old He x Fr with Je x Fr steers (20/grp), showed that the Je x Fr group had lighter carcass weights (93%; P<0.001), yellower fat, slightly lower weight-adjusted dressing-out percentages (P<0.01), heavier weight-adjusted livers (P<0.01), and longer carcasses at the same weight (P<0.001). In Trial 2, 27-month Je x Fr steers (n=15) were compared with He x Fr (n=15) and Angus steers (n=14). Differences similar to those for Trial 1 were shown, and in addition the Je x Fr steers had lower fat depths and a lower yield of several cuts from the round. For both trials the Je x Fr group had a more mature pattern of incisor teeth eruption. For Trial 2 the quality of meat from the longissimus muscle did not differ between groups for ultimate pH, intramuscular fat level, colour, Warner-Bratzler shear force, or water-holding capacity. Sensory analysis by a trained panel revealed no differences in tenderness, flavour, or juiciness, in contrast to some other reports where beef from Jersey or Jersey-cross cattle has been favoured. These results indicate that the Je x Fr steers in these trials offered no advantages relative to He x Fr or Angus cattle, but they did show some minor disadvantages. These results, however, need to be considered alongside other reports indicating that Jersey or Jersey-cross steers will sometimes yield beef with advantages in levels of marbling fat and palatability.

Keywords: Beef carcass; meat tenderness; teeth eruption; muscling.

INTRODUCTION

With an increasing number of Jersey and Jersey-cross cows in the New Zealand dairy industry (a 24% increase from 2000/01 to 2005/06, and the dairy herd comprising 14.6% Jersey and 30.1% Friesian-Jersey cross cows; LIC (2006)), there is widespread interest in the value of the male progeny of these animals for meat production. It is well known that the mature weight of Jersey cattle is low relative to most other breeds (Arango *et al*., 2002), which probably explains at least in part their low growth rate (Everitt & Ward, 1974; Barton & Pleasants, 1997). However, the low mature weight also means that the Jersey or their crosses are fatter at any set weight so they may be more efficient in attaining a specified level of intramuscular or subcutaneous fat (Smith *et al*., 1976). Also the lower efficiency associated with slower growth on pasture can be offset to some extent by having a higher stocking rate (Everitt & Ward, 1974; Muir *et al*., 2001), and the efficiency of lean tissue growth was shown by Hind (1978) to be similar for Jersey and Friesian steers. In reviewing the information on carcass and meat quality for dairy breeds, Fisher & Wood (1995) listed the three main supposed disadvantages as being poor conformation, "wrong" fat distribution, and inferior meat quality. They then went on to refute the second two points by pointing out that specific levels of intramuscular fat were reached at lower levels of dissectible carcass fat for Friesian and Jersey cattle, and particularly for Jersey cattle (Fisher *et al*., 1983; Siebert *et al*., 1996), and that numerous studies had shown that palatability of beef was at least as acceptable as that from beef breeds, with beef from Jersey or Jersey-cross cattle being rated at or near the top in a number of comparisons (Ramsey *et al*., 1963; Bond *et al*., 1972; Campion *et al*., 1975; Purchas & Barton, 1976; Koch *et al*., 1976; Moore & Bass, 1978). Butler-Hogg & Wood (1982) noted that a less desirable aspect of fat partitioning in dairy breeds generally, and for the Jersey in particular, is the high proportion of total fat in the non-carcass depots, such as those around the kidneys and the digestive tract, which has a negative effect on dressing-out percent.

This paper reports the results of two trials in which Jersey-Friesian cross steers were compared with Hereford-Friesian cross steers and Angus steers for carcass characteristics (both trials) and meat quality (one trial). Information on Jersey-Friesian cross steers is important in light of the contribution their dams make to the dairy cow population in New Zealand.

[1]Institute of Veterinary Animal and Biomedical Sciences, Massey University.

MATERIALS AND METHODS

For Trial 1 the 20 Hereford-Friesian (He x Fr) and 20 Jersey-Friesian (Je x Fr) cross steers calves were brought together at an age of approximately four months to Limestone Downs, a farm on the west coast of the Waikato region of New Zealand, and raised together on pasture to an age of about 33 months when they were slaughtered under normal commercial conditions at the beef plant of AFFCo Manawatu (Feilding) in June 2004. Measurements made at the plant included liver weights, carcass length from the distal edge of the tarsal bones to midway along the cranial edge of the first rib, body length from the distal edge of the cut made through the pelvic bone at splitting to midway along the cranial edge of the first rib, and a muscling score on the three-point scale, with 1 being the thickest muscling. Samples of subcutaneous fat from the mid-side region over the last rib were collected for assessment of fat colour using a Minolta Chromameter (CR-200) at approximately 4 and 24 hour *post mortem*.

The 44 steers of Trial 2, which included 15 each of the same two crosses as Trial 1 plus an Angus group (n = 14), were brought together at an age of approximately 6 months and run on pasture on the Massey University research farms to an age of about 27 months when they were slaughtered under normal commercial conditions at the same plant as for Trial 1 cattle. The same measurements were made at slaughter as for Trial 1, but in addition a sample (1.5 to 2 kg) of the longissimus muscle from the cube-roll (thoracic) region of the right side was taken the day after slaughter. At the same time measurements were made of the cross-sectional measurements of the longissimus muscle between the 12^{th} and 13^{th} rib, of fat depth over the lateral one third of that muscle, and of the weights of the topside (cap removed, primarily the semimembranosus and adductor muscles), outside (mainly the gluteobiceps and semitendinosus muscles), and knuckle (the quadriceps femoris muscle) cuts from both sides at the time of boning. The longissimus sample was aged at 1-3°C for 6 days before being frozen and stored at -18 to -20°C until assessed for quality within 4 months.

Laboratory measures of meat-quality-related characteristics were carried out on samples from all 44 animals following procedures described by Purchas *et al*. (2002). Briefly, these included intramuscular fat by Soxhlet extraction, ultimate pH in a muscle homogenate, meat colour by reflectance spectrophotometry, shear force of cooked samples with a Warner-Bratzler (WB) shear device, sarcomere length by laser diffraction, muscle fibre diameter by microscopy, and myofibrillar fragmentation index (MFI) by a filtration method.

A panel of 10 trained New Zealand panellists assessed cooked samples of beef from 12 randomly selected animals within each group in sets of 6 samples over 12 sessions on the basis of beef flavour strength, tenderness, juiciness and quality. Quality was defined as a composite of flavour, tenderness, and juiciness where high quality scores denoted that it was tender but not too tender, juicy but not too juicy, and flavour was adequate but not too strong and there were no significant off-flavours (*i.e.* non-beef flavours). All items were assessed on 100 mm lines with descriptive terms at each end and a centre mark. Steaks (25 mm thick) were cooked to an internal temperature of 72°C in a Silex clam cooker (Purchas *et al*., 2002). Ten samples (excluding the edge pieces) were cut from the cooked steaks immediately after cooking and served to the panellists hot. Each panellist evaluated samples from two steaks from each of the 36 animals in such a way that effects of session and sequence of tasting could be accounted for in calculating animal means.

Data were analysed using the GLM procedure within the SAS programme (SAS Institute, Cary, NC, USA) as a one-way analysis of variance with a covariate included when appropriate, and multiple comparisons were made using the LSD test.

RESULTS AND DISCUSSION

Carcass characteristics

Carcasses from the Je x Fr steers of Trial 2 were significantly lighter than those of either the He x Fr or Angus steers (Table 1), despite the fact that they did not differ significantly from the Angus steers in final live weight on the farm. This was due to a significantly lower dressing-out percentage even after adjusting for carcass weight differences. The Je x Fr carcasses were of poorer conformation as indicated by greater length at a set weight, greater legginess, and a significantly poorer muscling score (Table 1). In addition the fat of that group was more yellow as assessed either subjectively or objectively, as has been shown in a number of other studies (Morgan *et al*., 1969; Purchas & Barton, 1976). Mean liver weights were greatest for the Je x Fr group and were higher for the He x Fr group than for the Angus after adjustments for differences in carcass weight (Table 1). Similar results were reported by Taylor & Murray (1991) where, for non-lactating cows, and relative to the Angus, liver weights per unit liveweight were greater for Friesians and Jerseys by 9.3% and 26.8%, respectively.

Table 1: Means for body weight and carcass characteristics of 27-month Angus, Hereford x Friesian (He x Fr) and Jersey x Friesian (Je x Fr) steers. Means within a row with no following letters or with a common letter do not differ significantly (P > 0.05).

	Group				Carcass weight effect[a]	R^2(%) RSD[b]
	Angus	He x Fr	Je x Fr	Effect[a]		
Number of animals	14	15	15			
Farm live weight (kg)	562.7ab	578.0b	542.0a	*		19 (32.3)
Plant weight (kg)	528.2a	553.1b	516.4a	*		20 (32.0)
Carcass weight (kg)	291.4b	299.4b	269.1a	***		34 (18.7)
Subjective yellowness	2.79a	2.73a	4.00b	***		42 (0.72)
Fat colour (~4 h):						
L* (lightness)	56.7b	55.8b	54.4	*		20 (1.9)
a* (redness)	6.01	5.03	5.52	ns		4 (2.02)
b* (yellowness)	14.5a	15.6a	19.1b	***		34 (2.9)
Dressing-out % (farm)	51.7b	51.4b	50.2a	*	***	54 (1.1)
Liver weight (kg)	6.56a	7.28b	8.09c	**	**	65 (0.47)
Carcass length (mm)	2119a	2156b	2293c	***	**	73 (42)
Body length (mm)	1498a	1529b	1602c	***	**	64 (31)
"legginess" (%)[c]	29.3a	29.1a	30.2b	*	ns	16 (0.9)
Muscling score[d] (1 to 3)	2.03	2.07	2.30	ns	***	39 (0.28)
Fat depth (mm)	3.26b	3.05b	1.71a	**	ns	30 (0.97)
"Eye"-muscle area (cm^2)	66.6	68.3	67.0	ns	**	19 (5.8)
3-cut weight (kg)[e]	18.6b	17.9b	16.9a	***	***	85 (0.7)

[a]ns = P > 0.10; + = P < 0.10; * = P < 0.05; ** = P < 0.01; *** = 0.001.
[b]R^2% = coefficient of determination; RSD = residual standard deviation.
[c]Legginess = ((carcass length – body length)*100)/carcass length.
[d]1 = excellent muscling; 2 = good muscling; 3 = poor muscling.
[e]Topside + outside + knuckle cuts from both sides.

Details of Trial 1 results are not included here, because they were very similar to those of Trial 2 in showing that, relative to the He x Fr steers of the same age, the Je x Fr steers had significantly (P < 0.05) lighter carcasses, a lower dressing-out percent, longer carcasses at the same weight, poorer muscling scores, yellower fat, and heavier livers.

Mean fat depth was lower for the Je x Fr group of Trial 2 (Table 1), and, although eye-muscle areas at the same carcass weight did not differ, the combined weight of three major hind-quarter cuts was significantly lower (Table 1), which was consistent with the lower muscling score. As the cuts weight was adjusted to a common carcass weight by covariance, this is an index of yield as a percentage of carcass weight. When carcass classification results from both these trials and a third trial involving Je x Fr and He x Fr steers, which was similar to Trial 1 but run a year later, were combined, the percentage allocated to the poorest muscling class (class 3) was 42.9% for the 56 Jersey crosses and 5.8% for the 52 Hereford crosses.

Results for both Trials 1 and 2 suggested that the Je x Fr steers were more mature than the He x Fr group in terms of their teeth eruption patterns, with the proportion with six permanent incisors erupted being 52 and 10%, respectively for Trial 1, and the proportion with 4 permanent incisors erupted being 64 and 40%, respectively for the younger steers of Trial 2. Graham & Price (1982) discussed other reports of breed differences in teeth eruption patterns. Such differences may be important when carcass grades are based on teeth eruption patterns.

Meat quality characteristics

Laboratory measures of meat quality (Table 2) showed few significant differences between the three groups. The Je x Fr group had the highest mean intramuscular fat level, as has been reported in other comparisons (Koch *et al*., 1976; Purchas & Barton, 1976; Bass *et al*., 1981; Fisher *et al*., 1983; Siebert *et al*., 1996), but the difference was not significant in the current study, and was not reflected in differences in shear force values, which were non-significantly highest in the Je x Fr group (Table 2). The significantly lower cooking loss for the He x Fr group may reflect the slightly higher mean ultimate pH for that group. Objective colour measures indicated that Angus samples gave significantly higher values for lightness, redness and yellowness than the He x Fr group, but the differences with the Je x Fr were not significant for redness or yellowness. Meat fragments from the He x Fr group were less fragile than that from the other two groups according to MFI values (Table 2).

Table 2: Means for objective measurements of meat quality of the longissimus muscle (cube-roll cut) for 27-month Angus, Hereford x Friesian (He x Fr) and Jersey x Friesian (Je x Fr) steers. Means within a row with no following letters or with a common letter do not differ significantly (P > 0.05).

	Group				R^2(%)
	Angus	**He x Fr**	**Je x Fr**	**Effect[a]**	**(RSD)[b]**
Intramuscular fat %	3.03	2.91	3.33	ns	1 (1.73)
Ultimate meat pH	5.61	5.71	5.64	ns	6 (0.17)
Muscle fibre diam. (μm)	70.4	68.8	73.0	ns	6 (7.5)
Meat colour parameters:					
L* (lightness)	37.0b	35.1a	35.0a	**	26 (1.5)
a* (redness)	16.7b	14.3a	15.4ab	*	17 (2.2)
b* (yellowness)	6.80b	4.83a	5.55ab	**	32 (1.21)
WB work done	2.99	3.36	3.69	ns	4 (1.35)
WB initial yield (kg)	9.82	9.84	11.61	ns	4 (4.41)
WB peak force (kg)	12.13	11.78	13.80	ns	4 (4.71)
Cooking loss (%)	30.0b	27.6a	28.9b	**	25 (1.8)
Sarcomere length (μm)	1.90	1.77	1.81	ns	6 (0.23)
MFI[c]	88.0a	93.8b	88.0a	*	17 (6.4)
Drip loss to 48 h (%)	10.22	9.15	9.66	ns	5 (1.87)
Expressed juice (cm^2/g)	42.9	42.2	42.8	ns	2 (2.6)

[a]ns = P > 0.10; + = P < 0.10; * = P < 0.05; ** = P < 0.01; *** = 0.001.
[b]R^2% = coefficient of determination; RSD = residual standard deviation.
[c]Myofibrillar Fragmentation Index.

Table 3: Means for measurements of meat quality for the longissimus muscle (cube-roll cut) made by a 10-member sensory panel for 27-month Angus, Hereford x Friesian (He x Fr) and Jersey x Friesian (Je x Fr) steers. The scale used for each characteristic was from 0 to 100 with higher values indicating stronger flavour, greater tenderness, greater juiciness, or better quality.

	Group				R^2(%)
	Angus	**He x Fr**	**Je x Fr**	**Effect[a]**	**(RSD)[b]**
Number of animals	12	12	12		
Beef flavour strength	52.4	55.3	53.6	ns	8 (4.4)
Beef tenderness	51.7	48.8	44.5	ns	3 (18.2)
Beef Juiciness	46.3	48.5	45.1	ns	6 (5.7)
Beef quality	50.6	49.6	45.2	ns	3 (15.0)
Uncooked steak wt. (g)	197.1	181.3	176.9	ns	9 (29.7)
Cooking time (min)	5.9	5.8	5.5	ns	5 (1.0)
Cooking loss (%)	22.5	20.2	20.7	+	13 (2.7)

[a]ns = P > 0.10; + = P < 0.10.
[b]R^2% = coefficient of determination; RSD = residual standard deviation.

Sensory analysis by a trained sensory panel revealed no significant differences between the three groups on the basis of steaks from 12 animals within each group (Table 3). This may have been partly attributable to the limited numbers of animals represented, and to the wide between-animal variation shown, particularly for tenderness and beef quality (as shown by the RSD values in Table 3). The lack of any suggestion of superiority for the Je x Fr group does not support the evidence from a number of other studies listed in the introduction where the tenderness of beef from Jersey or Jersey-cross cattle has tended to be favoured, although this is not invariably the case; in the research of Purchas & Barton (1976), for example, beef from straight Jersey steers had significantly lower shear forces than that from Angus and Friesian steers in only one of two trials, and only in non-cold-shortened samples within that trial. The current results do emphasise, however, that meat quality differences between groups of cattle, particularly in terms of beef tenderness, are notoriously variable from one study to another. This may be due at least in part to the fact that there are a number of intrinsic determinants of tenderness of beef (Purchas, 2004), and that the ultimate tenderness of a sample may be limited by any one or a combination of these.

CONCLUSIONS

Results of the trials reported here showed no advantages of Jersey-cross steers in terms of meat quality characteristics, and some disadvantages with regard to carcass size at a set age and carcass characteristics including dressing-out percentage, fat yellowness, and muscularity. However, these results need to be considered alongside a number of other reports indicating that the quality of beef from Jersey or Jersey-cross cattle is as good or better than that from other cattle breeds.

ACKNOWLEDGEMENTS

The assistance and advice of Dr Lisa Duizer in the conduct of the sensory panels is acknowledged with gratitude.

REFERENCES

Arango, J.A.; Cundiff, L.V.; Van Vleck, L.D. 2002: Breed comparisons of Angus, Charolais, Herford, Jersey, Limousin, Simmental, and South Devon for weight, weight adjusted for body condition score, height, and body condition score of cows. *Journal of Animal Science* **80**: 3123-3132.

Barton, R.A.; Pleasants, A.B. 1997: Comparison of the carcass characteristics of steers of different breeds and pre-weaning environments slaughtered at 30 months of age. *New Zealand Journal of Agricultural Research* **40**: 57-68.

Bass, J.J.; Carter, A.H.; Johnson, D.L.; Baker, R.L.; Jones, K.R. 1981: Sire-breed comparison of carcass composition of steers from Angus dams. *Journal of Agricultural Science, Cambridge* **97**: 515-522.

Bond, J; Hooven, N.W.; Warick, E.J.; Hiner, R.L.; Richardson, G.V. 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. *Journal of Animal Science* **34**: 1046-1053.

Butler-Hogg, B.W.; Wood, J.D. 1982: The partition of body fat in British Friesian and Jersey steers. *Animal Production* **35**: 253-262.

Campion, D.R.; Crouse, J.D.; Dikeman, M.E. 1975: Predictive value of USDA beef quality grade factors for cooked meat palatability. *Journal of Food Science* **40**: 1225-1228.

Everitt, G.C.; Ward, J.D.B. 1974: Bull beef production. *Ruakura Farmers Conference Proceeding.* Pp. 81-96.

Fisher, A.V.; Wood, J.D.; Stevens, G.; Robelin, J. 1983: The relationship between carcass fatness and the lipid and protein content of beef. *Proceedings of the 29th European Meeting of Meat Research Workers* **29**: 48-54.

Fisher, A.V.; Wood, J.D. 1995: Carcass and meat quality from dairy breeds of cattle. *Meat Focus International* **4**(5): 198-203.

Graham, W.C.; Price, M.A. 1982: Dentition as a measure of physiological age in cows of different breed types. *Canadian Journal of Animal Science* **62**: 745-750.

Hind, E. 1978: Efficiency of lean meat production by British Friesian and Jersey steers. *Animal Production* **27**: 181-189.

Koch, R.M.; Dikeman, M.E.; Allen, D.M.; May, M.; Crouse, J.D.; Campion, D.R. 1976: Characterization of biological types of cattle. III. Carcass composition, quality and palatability. *Journal of Animal Science* **43**: 48-62.

LIC. 2006: New Zealand Dairy Statistics annual publications. www.lic.co.nz. (accessed 3 March, 2007).

Moore, V.J.; Bass, J.J. 1978: Palatability of cross-bred beef. *Journal of Agricultural Science, Cambridge* **90**: 93-95.

Morgan, J.H.L.; Pickering, F.S.; Everitt, G.C. 1969: Some factors affecting yellow fat colour in cattle. *Proceedings of the New Zealand Society of Animal Production* **29**: 164-175.

Muir, P.D.; Fugle, C.J.; Smith, N.B.; Ormond, A.W.A. 2001: A comparison of bull beef production from Friesian type and selected Jersey type calves. *Proceedings of the New Zealand Grasslands Association* **63**: 203-207.

Purchas, R.W. 2004: Tenderness measurement. In: Jensen, W.K.; Devine, C.E.; Dikeman, M.E. eds. Encyclopedia of meat science. Elsevier, Oxford, pp. 1370-1376.

Purchas, R.W.; Barton, R.A. 1976: The tenderness of meat from several breeds of cattle raised under New Zealand pastoral conditions. *New Zealand Journal of Agricultural Research* **19**: 421-428.

Purchas, R.W.; Burnham, D.L.; Morris, S.T. 2002: Effects of growth potential and growth path on tenderness of beef longissimus muscle from bulls and steers. *Journal of Animal Science* **80**: 3211-3221.

Ramsey, C.B.; Cole, J.W.; Meyer, B.H.; Temple, R.S. 1963: Effects of type of breed of British, zebu and dairy cattle on production, palatability and composition. II. Palatability differences and cooking losses as determined by laboratory and family panels. *Journal of Animal Science* **22**: 1001-1008.

Seibert, B.D.; Deland, M.P.; Pitchford, W.S. 1996: Breed differences in the fatty acid composition of subcutaneous and intramuscular lipid of early and late maturing, grain-finished cattle. *Australian Journal of Agricultural Research* **47**: 943-952.

Smith, G.M.; Laster, D.B.; Cundiff, L.V.; Gregory, K.E. 1976: Characterization of biological types of cattle. II. Postweaning growth and feed efficiency of steers. *Journal of Animal Science* **43**: 37-47.

Taylor, St C.S.; Murray, J.I. 1991: Effect of feeding level, breed and milking potential on body tissues and organs of mature, non-lactating cows. *Animal Production* **53**: 27-38.