A comparison of two methods of castration of post-pubertal beef cattle and their effect on behaviour, growth and ultimate pH

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ABSTRACT

This study aimed to evaluate the effect of surgical and immunocastration of post-pubertal beef cattle on their sexual and aggressive behaviour, growth and meat quality. Forty mixed-breed bulls were assigned to one of four treatments (n = 10): steers (S) castrated at 11 months of age, late castrates (LC) surgically castrated at 17 months of age (Day 1), immunocastrates (I) vaccinated against GnRH at 17 months of age (Day 1) and entire bulls (B). Sexual and aggressive behaviour was monitored at monthly intervals and prior to slaughter, animals were weighed and blood sampled fortnightly. All treatments were slaughtered at 22 months of age after which carcass composition and meat quality (pH_u) were assessed. Plasma testosterone concentrations declined to the level of steers by Day 14 for late castrates and by Day 28 for immunocastrates and remained lower than for entire bulls through to slaughter. Entire bulls had a heavier hot carcass weight (HCW) than I, LC and S. Immunocastrates were heavier than LC and S. Treatment had no effect on pH_u although late castrates tended to have a higher mean pH_u than immunocastrates and steers. From Day 0 to slaughter, rates of sexual and aggressive behaviour declined significantly for bulls, late castrates and immunocastrates to be similar to steers. There was a tendency for bulls to show higher levels of both sexual and aggressive behaviour during lairage.

Keywords: bull beef; surgical castration; immunocastration; behaviour; growth; meat ultimate pH.

INTRODUCTION

Aggressive interactions and riding behaviour of bulls can lead to high pH meat (Price and Tennessen, 1981). Pre-pubertal castration diminishes such behaviour, but at the cost of reduced weight gain (Field, 1971). An alternative procedure may be to delay castration until after puberty but prior to slaughter to take advantage of the superior growth rates of bulls, yet achieve the superior meat quality of steers. Castration of post-pubertal bulls can be carried out in at least two different ways. Surgical castration involves the surgical removal of both testes from the scrotal sac following administration of a local anaesthetic. Providing surgical castration is carried out correctly testosterone production from the testes ceases permanently. The second method involves actively immunising the animal against gonadotrophin-releasing hormone (GnRH). The antibodies raised against GnRH prevent the release of gonadotrophins from the pituitary and as a consequence testosterone production in the testes ceases temporarily (Robertson *et al.,* 1979). To date immunocastration has been successful in reducing rates of sexual and aggressive behaviour of pre or peri-pubertal bulls (Robertson et al., 1979; Teague *at al.,* 1992; Finnerty *et al.,* 1992; Adams and Adams, 1992). This study aimed to evaluate the effects of surgical and immunocastration on the behaviour, growth and meat quality (pH_u) of post-pubertal bulls.

MATERIALS AND METHODS

Animals

Forty mixed-breed intact bulls were blocked by weight and randomly allocated to four treatment groups (n = 10). Two groups were surgically castrated, one (steers) at 11 months of age, and a second (late castrates) at 17 months of age (designated Day 1). A third group (immunocastrates) were vaccinated against GnRH (Vaxstrate, Peptech Australia; Hoskinson *et al.,* 1990) at 17 months of age (Day 1) and given a booster immunisation 14 Days later. The fourth group (bulls) remained intact.

Following castration and immunocastration (Day 1) all treatments were run in one mob and grazed on pasture until Day 28 when they were fed a combination of pasture and brassica forage crop until slaughter. Twenty-four hour fasted liveweights were recorded on Days 1 (prior to castration and immunocastration), 28 (prior to grazing the crop) and 129 (prior to slaughter). A blood sample was collected from the tail vein of all animals at two weekly intervals. Plasma testosterone concentrations were measured using an in-house indirect radioimmunoassay. Intra-assay CV's were 21.7%, 10.0% and 13.4% for three samples containing 2.5, 5.5 and 11 ng/ml testosterone, respectively. Inter-assay variation for the same three samples was 23.6%, 11.0% and 25.1% respectively. Assay sensitivity was 0.069 ng/ml. Cattle were slaughtered over two days (Day 134 and 135) after which hot carcass weight (HCW), fat depth (over the 12th rib), neck muscle thickness and muscle ultimate pH (pH_u) were measured.

Behaviour

Cattle were observed on 5 occasions at monthly intervals. For each observation the cattle were separated into two groups of 20 (comprised of 5 animals from each treatment group) and held in adjacent pens approximately 14m x 17m. All occurrences of sexual (mounts, attempted

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mounts and flehmen) and aggressive (bunts, head-to-head contact and pawing the ground) behaviour were recorded for a total of 100 minutes per group. Prior to slaughter cattle were held in lairage at the slaughter plant for 22 hours in the same groups as described above. Each group was observed continuously and all occurrences of sexual (mounts, attempted mounts) and aggressive (bunts, head-to-heads) behaviour recorded. The groups were slaughtered on consecutive days.

Statistical Analysis

Liveweight, meat quality and carcass composition data were analysed by ANOVA adjusting for initial live–weight where appropriate. Monthly behaviour data were analysed by a 2-factor repeated measures ANOVA and lairage behaviour measures by a 2-way ANOVA with log or square root transformation when the data were not normally distributed. Significance levels were set at $p < 0.05$.

RESULTS

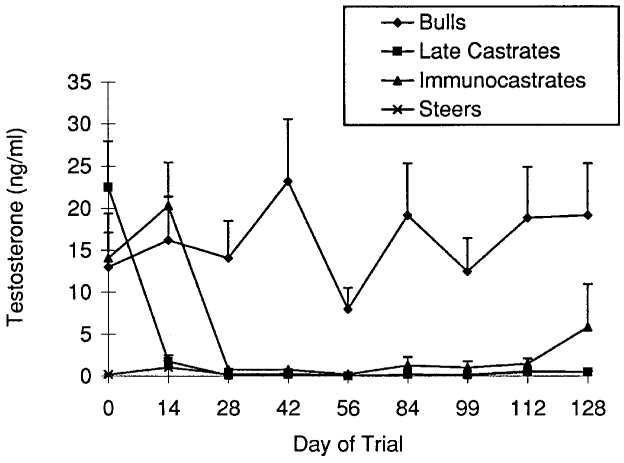
Growth, carcass composition and meat quality

For the first 29 Days the late castrates had lower growth rates than the entire bulls, immunocastrates and steers. Bulls and immunocastrates had greater fasted liveweights than late castrates and all three were heavier than steers (Table 1). From Day 30 until slaughter entire bulls had significantly higher growth rates than late castrates, immunocastrates and steers. The late castrates had significantly lower growth rates than steers and there were no differences in ADG between immunocastrates and steers and late castrates and immunocastrates. Entire bulls had greater HCW than all other treatments, while immunocastrates were heavier than late castrates and steers and there was no difference between the latter two (Table 1). Immunocastrates and late castrates had fat depths between those of bulls and steers. The neck muscle size of immunocastrates was between that of bulls and steers, and late castrates were not different from steers. Treatment had no effect on pH_u although there was a tendency ($p < 0.10$) for bulls and late castrates to have a higher pH_u than immunocastrates and steers.

Testes weight and testosterone

Figure 1 shows that the levels of plasma testosterone in late castrates decreased to that of steers within two weeks of surgical castration. Two weeks after the primary immunisation the testosterone levels in immunocastrates had not changed, but by four weeks they had declined to the level of steers. The increase in mean testosterone concentrations for immunocastrates from Day 84 was due to higher values in one animal only. At slaughter the entire bulls had significantly higher testosterone concentrations than all the other treatments. Immunocastrates had significantly lighter testes weights at slaughter than entire bulls (594 ± 35g vs 328 ± 39g, $p < 0.001$).

FIGURE 1: Mean (± s.e.m) plasma testosterone concentration over time for bulls, late castrates, immunocastrates and steers.



Behaviour

Figure 2 shows the mean (averaged for the two groups of five) occurrences of (a) sexual and (b) aggressive behaviour for each treatment group during 5 monthly observations. Rates of sexual and aggressive behaviour declined significantly for bulls, late castrates and immunocastrates from Day 0 until slaughter, however, there was no difference in the rate of aggressive or sexual behaviour between these treatments. Rates of sexual and aggressive behaviour for steers did not change from Day 0 until slaughter. Figure 3 gives the mean occurrence of the sexual and aggressive behaviour observed during lairage. Bulls had numerically higher levels of both sexual and aggressive behaviour than all other treatments. The only significant differences between treatments was the lower rates of aggressive behaviour for steers in comparison with bulls.

TABLE 1: Average daily gain (ADG) and fasted liveweights (kg), carcass composition and meat quality of bulls, late castrates, immunocastrates and steers. Values presented are means (± s.e.m).

TREATMENT	ADG Day 1-29	Liveweight Day 29	ADG Day 30-129	Liveweight Day 129	HCW (kg)	Neck Muscle (mm)	Fat (mm)	Depth pH_u
Bulls	0.60 ± 0.06^{a}	383 ± 3^{a}	0.99 ± 0.04^{a}	485 ± 7^{a}	262 ± 4^{a}	62 ± 2^{a}	1.40 ± 0.35^{b}	5.91 ± 0.09^{a}
Late castrates	0.07 ± 0.06^{b}	367 ± 3^{b}	0.67 ± 0.04^{c}	436 ± 7^{c}	234 ± 4^{c}	40 ± 2^{c}	1.85 ± 0.34^{ab}	5.89 ± 0.09^{a}
Immunocastrates	0.62 ± 0.08^{a}	384 ± 4^{a}	0.74 ± 0.04^{bc}	459 ± 7^{b}	245 ± 4^{b}	50 ± 2^{b}	2.06 ± 0.34^{ab}	5.67 ± 0.09^{a}
Steers	0.54 ± 0.05^{a}	359 ± 3^{c}	0.83 ± 0.04^{b}	447 ± 7^{abc}	235 ± 4^{c}	37 ± 2^{c}	2.48 ± 0.35^{a}	5.78 ± 0.09^{a}

^{a,b,c} Values within columns with different superscripts are significantly different ($p < 0.05$)

FIGURE 2: Mean (± s.e.m) occurrence of (a) sexual and (b) aggressive behaviour of bulls, late castrates, immunocastrates and steers in monthly pen tests.

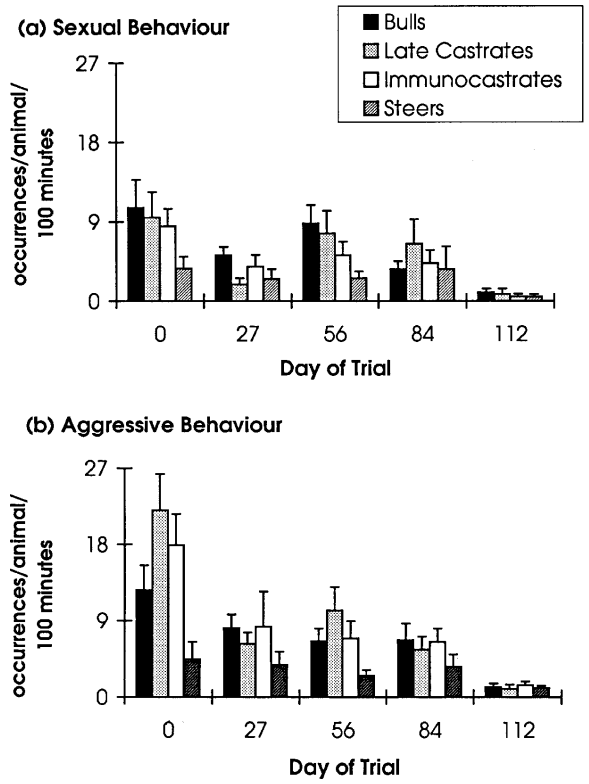
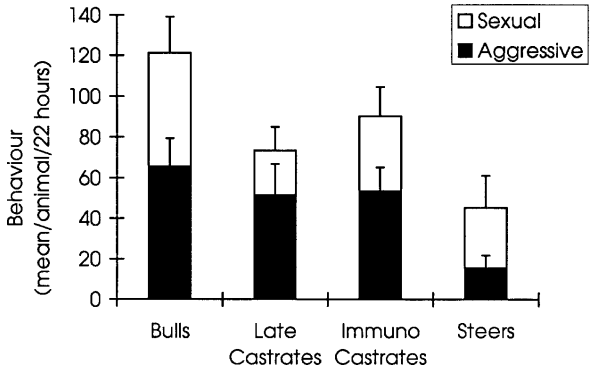


FIGURE 3: Mean (± s.e.m) occurrence of sexual and aggressive behaviour for bulls, late castrates, immunocastrates and steers during 22 hours of lairage prior to slaughter.



DISCUSSION

Both surgical castration and immunisation against GnRH were successful in reducing testosterone production in post-pubertal cattle. Surgical castration caused an immediate reduction in plasma testosterone levels (Cohen *et al.*, 1990) while testosterone levels for immunocastrates declined between two and four weeks post primary immunisation. Differences in the delay of testosterone decline between late castrates and immunocastrates may explain the differences in growth since androgen levels have been shown to be positively correlated with growth (Bass and Clark, 1989). There are however alternative explanations for these differences. Stress has been shown to have an adverse effect on growth (Klasing, 1985) and surgical castration causes decreased food intake, elevated cortisol and white blood cell counts, all of which are typical responses to an acute stressor (Chase *et al.*, 1991). A third factor to consider is the stress associated with a changing social structure within the mob. Social status is highly correlated with sexual status, with bulls positioned higher than steers (Bouissou *et al.*, 1986). It is likely that reducing testosterone levels of particular animals causes a decline in their social status (Bouissou *et al.*, 1986). Less dominant animals may be subject to higher stress levels and reduced access to food, space and other resources (Syme and Syme, 1979).

In an extensive survey of several slaughter plants Graafhuis and Devine (1994) reported that the average pH_u for bulls was 6.16 (n = 766) compared to 5.59 (n = 542) for steers. In this study, the pH of bulls (pH_u = 5.91) was lower, and that of the steers (pH_u = 5.78) higher, than might have been expected. Therefore it is not surprising that there were no differences between treatments and that we could not detect any effect of post-pubertal castration on ultimate pH. The control steers in this study were castrated at 11 months of age, which is several months later than is usual farm practice. Steers castrated at about this age have behavioural characteristics intermediate to bulls and steers castrated pre-pubertally (Bouissou *et al.*, 1986). In addition, the groups were comprised of animals from all treatments (of different sexual status). Thus, the behaviour of the treatments within a group may not have been typical of such animals had they been held in separate treatment groups.

We conclude that post-pubertal surgical castration has a dramatic effect on growth and provides no weight gain advantage over early castration. Immunocastration also results in a reduced growth rate, but to a lesser degree and therefore has an advantage over early castration. Post-pubertal castration produces carcasses with characteristics that are intermediate between bulls and steers. The effect of delayed castration on behaviour is inconclusive and needs further investigation.

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