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# The effect of castration on some muscles of red deer (*Cervus elaphus* L.).



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Individual muscles were dissected from the forequarter and hindquarter regions of four castrate and four entire male red deer, aged 27 months, just before the rut. Six forequarter muscles were found to be significantly lighter as a proportion of total side weight in castrates, and four hindquarter muscles were heavier. Overall, the total dissected forequarter muscles were proportionately 7% lighter ($P<0.01$) in castrates and the total hindquarter muscles were 7% heavier ($P<0.05$). Castrates also had significantly lighter heads than entire males ($P<0.05$).

**Keywords** deer; muscle development; carcass; castration; sex differences

## INTRODUCTION

Differences in muscle development between sexes have been demonstrated in sheep (Fourie *et al.* 1970; Lohse 1973; Jury *et al.* 1977) and cattle (Berg & Butterfield 1976; Brännäng 1971; Mukhoty & Berg 1973). Males deposit muscle at a faster rate than females and also have a higher proportion of total muscle in the neck and shoulder region; castrates are intermediate (Berg & Butterfield 1976; Fourie *et al.* 1970; Mukhoty & Berg 1973). There are no published reports of relative muscle development in red deer.

The present study was carried out as part of a programme investigating the effects of castration in red deer (Drew *et al.* 1978). The mating season (rut) occurs in April, and as this time approaches there is a clearly visible enlargement of the neck region in entire stags; no such change is apparent in castrates. Therefore, in this work, the deer were slaughtered just before the rut when any differences in muscle development were likely to be most evident.

## EXPERIMENTAL

### Animals and dissection

Four castrated (at 5 months of age) and four entire male red deer, all aged about 27 months, were slaughtered in mid March; the castrates were 16% lighter than the entire males. Details of the effects of castration on growth rate and body composition have been published by Drew *et al.* (1978). The hard antler had been removed from the entire males in mid February; the castrated deer did not develop pedicles or grow antlers.

Thirteen individual muscles from the forequarter and 12 from the hindquarter, totalling about half of the estimated muscle weight or 33% of total side weight (half-carcass plus half-head), were dissected out from the left half-carcass of each animal and weighed. Clear separation of *Mm brachiocephalicus* and *omotransversarius* was difficult, so these muscles have been grouped together. The *rhomboideus*, *splenius*, and *longissimus capitis* forequarter muscles from three castrates and three entires were retained for chemical analysis. Water, fat, and ash were determined on the entire muscle sample using standard procedures (freeze-drying, Soxhlet ether extraction for fat, muffle furnace at 550°C for ash, and protein by difference).

### Statistical methods

Between-sex comparisons of individual muscle weights were made using analysis of variance. Since castration incurred a considerable penalty in both growth rate and carcass weight, muscle weights were expressed as a percentage of total side weight (TSW).

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TABLE 1—Mean weights of half-heads and individual muscles dissected from the carcasses of 4 castrate and 4 entire male deer, expressed as a percentage of total side weight (TSW)

| | Castrates | Entires | SED |
|---|---|---|---|
| Mean TSW (kg) | 29.7 | 38.0 | 3.24* |
| Half-head weight (% TSW) | 8.13 | 9.19‡ | 0.345* |
| FOREQUARTER MUSCLES (% TSW) | | | |
| *Trapezius* | 0.50 | 0.49 | 0.028 |
| *Omotransversarius* } *Brachiocephalicus* } | 1.40 | 1.55 | 0.088 |
| *Sternocephalicus* | 0.38 | 0.53 | 0.086 |
| *Serratus ventralis* | 2.87 | 3.04 | 0.099 |
| *Rhomboideus* | 0.49 | 0.60 | 0.026** |
| *Splenius* | 0.18 | 0.32 | 0.026** |
| *Iliocostalis ventralis* | 0.24 | 0.29 | 0.031 |
| *Longissimus thoracis* | 5.54 | 5.28 | 0.157 |
| *Longissimus cervicis* | 0.24 | 0.35 | 0.079 |
| *Longissimus capitis* | 0.09 | 0.18 | 0.011** |
| *Longissimus atlantis* | 0.07 | 0.09 | 0.011(*)† |
| *Semispinalis* | 0.63 | 0.79 | 0.033** |
| *Spinalis* | 0.96 | 1.12 | 0.063** |
| Total dissected FQ muscle (kg) | 13.58 | 14.60 | 0.255** |
| HINDQUARTER MUSCLES (% TSW) | | | |
| *Biceps femoris* | 4.62 | 4.31 | 0.133(*)† |
| *Gluteus medius* | 1.98 | 1.92 | 0.057 |
| *Gluteus accessorius* } *Gluteus profundus* } | 0.45 | 0.44 | 0.021 |
| *Vastus lateralis* | 2.10 | 1.90 | 0.061* |
| *Vastus medialis* | 0.64 | 0.53 | 0.028** |
| *Vastus intermedius* | 0.52 | 0.49 | 0.042 |
| *Rectus femoris* | 1.87 | 1.81 | 0.101 |
| *Semitendinosus* | 1.34 | 1.32 | 0.059 |
| *Semimembranosus* | 3.64 | 3.24 | 0.124* |
| *Adductor femoris* | 1.11 | 1.15 | 0.041 |
| *Iliopsoas* | 1.35 | 1.30 | 0.065 |
| Total dissected HQ muscle (kg) | 19.61 | 18.40 | 0.347* |

†(*)$P<0.10$ ‡Antler weight not included

TABLE 2—Mean muscle weight and chemical composition of 3 selected forequarter muscles from 3 castrates and 3 entire male red deer. The ratios of water:protein in the complete half-carcasses were 2.95 for the castrates and 3.14 for the entires ($P<0.01$)

| | Castrates | Entires | SED |
|---|---|---|---|
| *Rhomboideus* | | | |
| Muscle weight (g) | 145 | 229 | |
| Water (%) | 74.6 | 77.1 | 0.61* |
| Protein (%) | 21.5 | 19.4 | 0.66* |
| Fat (%) | 2.6 | 2.4 | 0.33 |
| Water:Protein | 3.47 | 3.98 | 0.13* |
| *Splenius* | | | |
| Muscle weight (g) | 55 | 120 | |
| Water (%) | 75.1 | 78.0 | 0.63** |
| Protein (%) | 21.5 | 18.9 | 0.65* |
| Fat (%) | 2.3 | 1.8 | 0.31 |
| Water:protein | 3.50 | 4.13 | 0.15* |
| *Longissimus capitis* | | | |
| Muscle weight (g) | 28 | 66 | |
| Water (%) | 73.5 | 77.5 | 0.98* |
| Protein (%) | 21.5 | 18.4 | 0.67** |
| Fat (%) | 3.9 | 3.0 | 0.71 |
| Water:Protein | 3.42 | 4.13 | 0.18** |

## RESULTS AND DISCUSSION

The mean weights for the dissected muscles and the head for the two groups of animals are given in Table 1. All means are expressed as a percentage of TSW.

### Forequarter muscles

Proportionately, six of the muscles were significantly lighter in castrates than in entires. They were *Mm longissimus capitis* (50% lighter in castrates, $P<0.01$), *splenius* (44%, $P<0.01$), *longissimus atlantis* (22% $P<0.01$), *semispinalis* (20%, $P<0.01$), *rhomboideus* (18% $P<0.01$), and *spinalis* (14%, $P<0.01$). Sex differences have previously been reported for all of these muscles in sheep and/or cattle (Brännäng 1971; Lohse 1973; Jury *et al.* 1977). Many other muscles were also proportionately lighter (though not significantly so) in castrates than in entires. The overall effect of castration was a reduction of 7% in the total forequarter muscle weight ($P<0.01$). Those muscles reduced in size by castration are located principally in the region of the neck and thorax. Associated with the lighter forequarter muscle weight of the castrate was a head 12% lighter ($P<0.05$) than that of the entire male.

### Hindquarter muscles

Proportionately, four of the muscles were significantly heavier in castrates than in entires. They were *Mm vastus lateralis* (11% heavier in castrates, $P<0.05$), *vastus medialis* (21%, $P<0.01$), *semimembranosus* (12%, $P<0.05$), and the *biceps femoris* (7%, $P<0.10$). Of these the *biceps femoris* has also been found to be proportionately heavier in female sheep than in males (Jury *et al.* 1977). The overall effect of castration was a 7% increase in total hindquarter muscle weight ($P<0.05$). This is similar to the situation in cattle—heifers and steers have a higher proportion of hindquarter than bulls (Brännäng 1966, 1971; Berg & Butterfield 1976).

### Chemical composition of the muscles

Chemical composition data for three selected sexually dimorphic muscles from the forequarter are presented in Table 2. Castration reduced the relative size of these muscles, their water content was significantly lower, and their protein content was higher. As a result, the water:protein ratio was significantly lower in castrates. Consequently, for these three muscles, the effect of castration in reducing muscle wet weight was much greater than the effect on muscle dry weight. The ratio of water:protein in the complete half carcass was also significantly lower in castrates than entires. This effect is in contrast to

that reported for cattle, whereby castration increases the fat content of the muscle mass yet decreases both water and protein, so that the ratio of water to protein is unaffected (Brännäng 1966).

In any analysis where proportions or percentages are used or values are expressed in relation to a total (e.g., TSW), an increase in a proportion in one region must be complemented by a decrease in some other region(s). Consequently, castrates with a lighter forequarter and head must be proportionately heavier in other parts of the body. This is apparent in the increase in hindquarter weight. Overall, the dissected muscles and the head account for 41% of the castrate TSW and 42% of the entire TSW. When the dissected fat is added, the values become 43.5% and 45.4% respectively.

Ideally a study such as this should be carried out using more animals slaughtered over a range of weights and ages (i.e., stages of the annual liveweight cycle), so that valid comparisons can be made at the same muscle or total side weight using analysis of covariance procedures. Although the differences are very marked, and considerable confidence can be attached to the trends reported here, the size of the differences between castrates and entires could have been much more accurately determined if more animals had been involved. Furthermore, the cellular mechanisms generating the differences between entires and castrates in muscle growth require elucidation.

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## REFERENCES

Berg, R. T.; Butterfield, R. M. 1976: "New Concepts of Cattle Growth", pp. 99–119. Halsted Press, John Wiley & Sons, New York.

Brännäng, E. 1966: Studies on monozygous cattle twins. XVIII. The effect of castration and age of castration on the growth rate, feed conversion and carcass traits of Swedish red and white cattle. Part I. *Lantbrukshog-skolans annaler 32:* 329–415.

———1971: Studies on monozygous cattle twins. XXIII. The effect of castration and age of castration on the development of single muscles, bones and special sex characters. Part II. *Swedish journal of agricultural research 1:* 69–78.

Drew, K. R.; Fennessy, P. F.; Greer, G. J. 1978: The growth and carcass characteristics of entire and castrate red stags. *Proceedings of the New Zealand Society of Animal Production 38:* 142–144.

Fourie, P. D.; Kirton, A. H.; Jury, K. E. 1970: Growth and development of sheep. II. Effect of breed and sex on the growth and carcass composition of the Southdown and Romney and their cross. *New Zealand journal of agricultural research 13:* 753–770.

Jury, K. E.; Fourie, P. D.; Kirton, A. H. 1977: Growth and development of sheep. IV. Growth of the musculature. *New Zealand journal of agricultural research 20:* 115–121.

Lohse, C. L. 1973: The influence of sex on muscle growth in Merino sheep. *Growth 37:* 177–187.