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The relationship of meat quality to age at slaughter and indicators of animal age in red deer stags and hinds

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ABSTRACT

Groups of five stags and hinds were slaughtered in late summer (February/March) to examine the effects of age and sex of animal on meat quality. For both sexes the groups were the following ages: 1, 2, 3 and 5 years. In the 2 year old age group for stags there were three weight groups and additionally there was one group of 8 year old stags and one of 13 year old hinds. The group mean hot carcass weight (HCW) range was 51 to 119 kg for stags and 43 to 57 kg for hinds. The HCW's tended to increase with age but the "light" and "medium" weight 2 year old males had lower ($p < 0.05$) mean HCW than all of the other male groups including the 1 year olds. The GR increase with age was much greater in stags than in hinds; 80% of the stags 3 years and older and 27% of the hinds 3 years and older graded over-fat. In both hinds and stags, GR was strongly related to carcass weight. Meat from 5 and 8 year old stags was much tougher ($p < 0.05$) than that from all other groups. Of all the attributes measured as possible indicators of animal age, only carcass neck a* value (redness) was able to accurately discriminate ages of animal and provided the best categorisation of animals into tenderness classes.

Keywords: red deer; meat quality; venison; age; carcass; tenderness.

INTRODUCTION

The quality of meat covers a wide range of variables relating to the appearance, palatability, nutritive value, safety and processing characteristics of the product. Primary purchase of meat is generally based on colour and appearance but continued purchase is based on palatability factors. Meat palatability depends upon such qualities as aroma and flavour, colour and appearance, and tenderness and juiciness. Consumer studies have shown that tenderness is the most important palatability factor in the acceptance of beef and probably other meats, including poultry and game (Bratzler, 1978). As tenderness appears to be the most important palatability factor, considerable research has been carried out relating this to factors such as breed, sex, age, plane of nutrition and post-slaughter handling in most livestock species, but similar work in deer was lacking. Generally toughness has been found to increase with animal age in other livestock species (Boccard *et al*., 1979).

Several quality indicators are subjectively evaluated in assessing meat quality in livestock species by various countries around the world. For example, in the USA, with the United States Department of Agriculture (USDA) grades, the "quality indicating factor" given primary importance in beef is the amount, distribution and texture of marbling in the exposed ribeye muscle. The classical index of age is dentition, however this is susceptible to misinterpretation. The period of eruption through to wear of the permanent incisor teeth and observations on the presence or absence of pairs of permanent incisors are commonly used for ageing sheep for farm management purposes and at slaughter. The time of eruption may be influenced by level of nutrition (Arrowsmith *et al*., 1974), sex (Wilson and Durkin, 1984) and breed/strain (Arrowsmith *et al*., 1974; Aitken and Meyer 1982), amongst other sources of variation. Tisdall *et al*., (1985) found, in a study of red deer, that in the vast majority of animals all permanent incisors erupted between 12 and 24 months of age and it was suggested that body weight had a marked influence.

MATERIALS AND METHODS

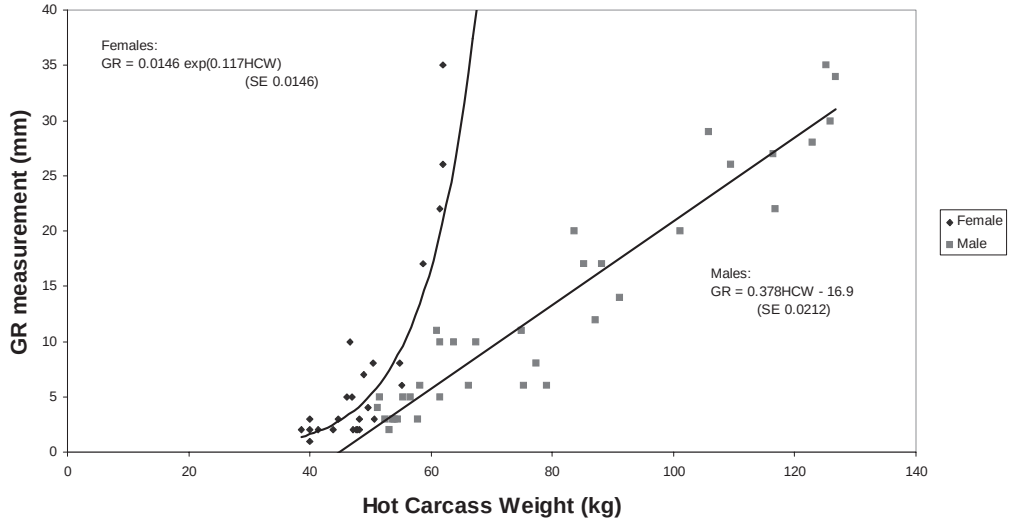
Sample Source

There were 12 sex/age/weight groups, with 5 animals per groups, consisting of 1, 2, 3, 5 and 13 year old hinds, 1, 1, 2 "light", 2 "medium", 2 "heavy", 3, 5 and 8 year old stags. The slaughters were structured such that two animals from each group were slaughtered on the first two occasions and one animal from each group was slaughtered on the last occasion. Each animal was slaughtered, and the carcass electrically stimulated and dressed under standard procedures at a commercial Deer Slaughter Plant.

Measurements

Carcass weights were recorded immediately after dressing and carcasses were placed in a chiller at 10°C, the temperature of which was then lowered to -1°C approximately 18 hours later. Carcass colour measurements were taken using a Minolta Chromameter CR200b at 24 hours post mortem. One measurement was taken at each position designated (rump, brisket and neck) for each animal. Each 'measurement' consisted of an L*, a* and b* value, which, for simplicity, can be thought of as 'lightness', 'redness' and 'yellowness' (CIE, 1978). Pedicle heights and circumferences were measured for all stags, the number and height of teeth, and jaw length were measured for all animals. Size and ossification of bones were determined according to procedures described by Boggs and Merkel (1982). The carcasses were cut and packaged on the day following slaughter and the LT and SM were frozen (-25°C) until analysis (1-2 months). Muscle pH and colour were measured (as described above) after 24 hours thawing at 2°C. Chemical composition analyses (fat, protein, ash, insolu-

FIGURE 1: Hot carcass weight vs GR measurement.



ble collagen and heat-soluble collagen) were carried out as described in Stevenson *et al*. (1992). MIRINZ Tenderometer measurements were performed on steaks cooked in plastic bags immersed in an 80°C waterbath for 1 hour (Seman *et al*., 1989) and on steaks grilled to an internal temperature of 65°C.

Statistical Methods

All data were analysed by ANOVA, with group as the treatment structure, investigating the sex by age factorial effect for "medium" weight animals and the different weight classes for two year old males separately. Muscle (LT or SM) and/or replicates were nested within animal as appropriate, with muscle and its interactions included in the treatment structure. Regression relationships were analysed by least squares, with log transformations to stabilize the variance as appropriate. The correlation matrix for all variables was calculated based on individual data.

RESULTS AND DISCUSSION

Indicators of animal age and meat quality

There were significant differences in carcass weight (Table 1) due to age, sex and weight group, but the most significant effect was that due to sex. Similarly to carcass weights, there were significant differences in GR measurements due to age and sex, but the most significant effect was due to sex. GR increased with increasing HCW (Figure 1), with a pattern that differed between sexes, but was not improved by adding age for either sex. The fitted equation for hinds is back-transformed from a log analysis. Above a carcass weight of 55 kg in hinds there were massive increases in GR but this was not related to age. The four hinds with greatest GR's (and heaviest carcasses) comprised two 13 year olds, one 5 year old and one 3 year old. A linear relationship was fitted for stags. In both cases the variance was stable. None of the 1 or 2 year olds graded over-fat. Of the 3 year olds and older animals, 4 out of 15 (27%) of the hinds graded overfat (AF1 and AF2) and 80% of the stags.

There was a general increase in percentage fat content with age in the two muscles analysed (Table 1). There were relatively little differences among the 2 year old stag groups. The LT had consistently higher fat content than the SM for all groups, although it was not significantly higher ($p > 0.05$) for 3 year old males but was significantly higher ($p < 0.05$) for all other groups. Both LT and SM fat contents were similar ($p > 0.05$) for stags and hinds of the same age, and the 13 year old hinds had a significantly greater mean fat content than all other groups. Overall, fat content in the topside muscle was lower than the striploin (1.07 vs 1.68, s.e.d. 0.27) and stags were generally higher in fat content than hinds (1.40 vs 1.10, s.e.d. 0.27, excluding 13 year old hinds which appeared to be abnormally high). The 13 year old hinds had the highest fat content in both muscles ($p < 0.05$). However, within the 13 year old females, the % fat content was extremely variable, ranging from 1.1 to 6.5 in LT and 0.8 to 2.4 in SM.

TABLE 1: Mean hot carcass weights (kg) and percentage fat content for each sex/age/weight group for each muscle

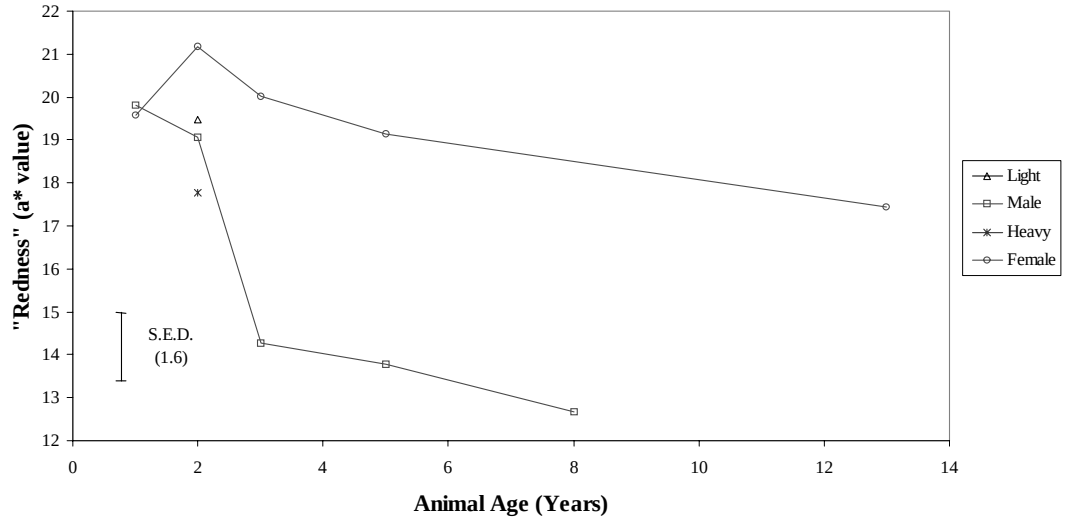
Age/weight (years/group)	Hot Carcass Weight (HCW)		% Fat Content LT		SM	
	Male	Female	Male	Female	Male	Female
1	61.1	43.5	1.36	1.13	0.94	0.81
2 "Light"	52.3		1.28		0.82	
2 "Medium"	55.7	47 5	1.31	0.85	0.92	0.55
2 "Heavy"	74.5		1.26		0.96	
3	82.3	47.1	1.36	1.42	1.17	0.92
5	109.7	49.2	2.10	1.89	1.53	1.26
8	118.6		2.30		1.04	
13		56.9		3.09		1.53

Standard Error Difference (s.e.d.) = 4.3 for HCW and 0.27 for % fat content.

As found by Tisdall *et al*., (1985), all permanent incisors were present at 2 years of age and the number of permanent incisors could only be used to distinguish between 1 and 2 year olds. Beyond 2 years of age, all deer had the same number of permanent incisors. All other teeth measurements were not at all useful or accurate for distinguishing between age or quality groups and they were also not easy to measure quickly and most likely would not have been practical at the speeds necessary in a commercial plant.

Of all the attributes measured, only carcass neck a*

FIGURE 2: Carcass colour vs animal age.



value (redness) was able to accurately discriminate ages of animal (Figure 2) and provided the best categorisation of animals into tenderness classes.

Measurements of Meat Quality

For the grilled steaks, stags were found to be tougher than hinds but there were no significant differences due to age, weight or muscle and there was a significant interaction between sex/age/weight group and muscle (Table 2). In particular the 3, 5 and 8 year old stags were tougher than the 3, 5 and 13 year old hinds for the LT but with the SM only the 5 year old males were significantly tougher ($p < 0.05$) than the other groups. With the waterbath method, there were significant sex and muscle effects but no other significant main effects or interactions. The hinds were more tender than stags and the LT was more tender than the SM. The hinds did not alter in tenderness with age for either muscle. In the LT there was a general increase in toughness with age for the stags but this was not so evident in the SM due to high values for the one and two year olds. The "medium" and "light" weight 2 year old stags were more tender than the other stag groups in the LT. The 1, "heavy" 2, 3 and 5 year old stags were tougher than all the hind groups in the LT.

CONCLUSIONS

Unless hind carcasses are visibly emaciated, the venison is of uniformly high quality irrespective of age, although carcass fatness increased exponentially with age. Also there would appear to be no reason to establish age classification for hinds in venison schedules from a meat quality point of view. Venison from stags 5 years of age and older is of poorer quality than that from 1 and 2 year old deer. Product from 3 year old stags is intermediate in quality. There is a case to develop a carcass classification system for stags with two age groups (1 and 2 year olds; 3 year olds and older). However, none of the variables traditionally used for classifying animals into age groups were accurate for deer.

TABLE 2: Mean tenderometer force scores (kgF) for each sex/age/weight group for each muscle for each cooking method

Age/weight	Grilled				Waterbath			
(years/group)	LT		SM		LT		SM	
	Male	Female	Male	Female	Male	Female	Male	Female
1	4.08	3.96	4.70	3.92	5.17	4.01	6.41	5.05
2 "Light"	4.26		3.69		4.24		5.37	
2 "Medium"	3.97	4.15	3.92	3.16	4.32	3.93	5.36	4.69
2 "Heavy"	4.45		4.74		5.63		5.76	
3	5.16	3.12	4.67	4.00	6.10	3.98	4.92	4.81
5	5.30	6.64	6.01	3.38	6.49	4.60	6.17	4.33
8	6.32		5.04		7.14		7.41	
13		3.81		3.72		4.59		4.74

s.e.d. = 0.69 for Grilled, 0.85 for Waterbath.

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