PE9.05 Some nutritive-value features of venison from red deer stags and hinds 31.00

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***Abstract*—Samples of the longissimus muscle from young (ca 20 mo) male (stags) and female (hinds) red deer were analysed for selected nutrients and bioactive compounds to determine gender effects and to enable comparisons with comparable data for beef and pork from the same laboratory. Samples from stags contained less fat (0.6 vs 1.1%), which led to a fatty-acid composition with more polyunsaturated fatty acids and a lower *n-6* to *n-3* ratio. Venison from hinds contained more vitamin E, taurine and coenzyme Q_{10}. Relative to pasture-finished beef, and making allowance for differences in intramuscular fat, venison had higher levels of coenzyme Q_{10}, taurine, and the long-chain *n-3* polyunsaturated fatty acids EPA and DHA. However the quantities of these acids present were low compared to levels in oily fish.**

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***Index Terms*—**carnosine, coenzyme Q_{10}, fatty acids, taurine.

I. INTRODUCTION

Data on the nutritive value of venison from New Zealand is available [1, 2], but there is limited information on whether this differs for venison from male and female deer. There is also no information on the concentrations of compounds such as coenzyme Q_{10}, carnosine, and taurine that are known to be present in meat [3], and for which there is increasing evidence that they have bioactive properties, in the sense that they are beneficial to health and well-being when included in the human diet. This paper reports the results of a trial in which a selection of characteristics related to the nutritive value of venison were measured in samples of the longissimus muscle from the shortloin cut of male and female red deer .

II. MATERIALS AND METHODS

Twenty red deer (*Cervus elaphus)* aged about 20mo comprising 10 stags (males) and 10 hinds (females) were slaughtered on the same morning at a meat plant (Venison Packers, Feilding, New Zealand) following normal commercial procedures that included low-voltage electrical stimulation (70v for 60 s). The stags and hinds were raised on different farms but they were all finished on an all-pasture diet. After overnight chilling the longissimus muscle from the pelvic bone to the last rib (the shortloin cut) was collected from both sides of each carcass, vacuum packed, and aged at 1-2 °C until 7 d post mortem when they were frozen at -20°C.

Analytical procedures

The analytical procedures and the procedures for measuring some meat quality-related characteristics were those described previously [4]. Briefly, they involved intramuscular fat levels by Soxhlet extraction, fatty-acid percentages by gas-liquid chromatography, coenzyme Q_{10}, carnosine, anserine, vitamin E and taurine by HPLC, haem iron and total iron by colorimetry, and ultimate pH of a muscle homogenate.

Statistical analysis

The data were analysed using a one-way analysis of variance model.

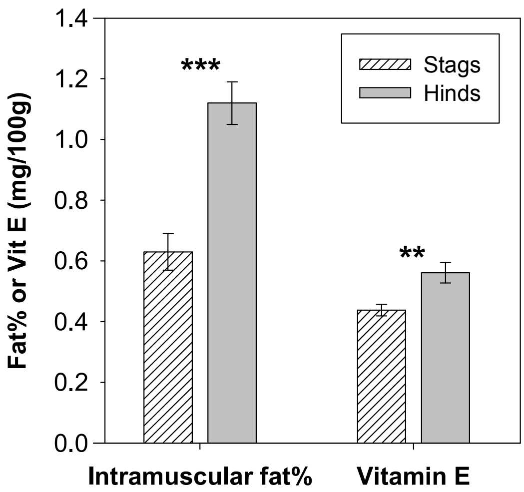
III. RESULTS AND DISCUSSION

The mean carcass weight was 3.4 kg heavier for the stag group (55.8 vs 52.4 kg; P = 0.042*), but soft-tissue depth GR over the last rib at a point vertically down from the *tuber coxae* on the hanging carcass as a measure of fatness was non-significantly greater for the hind group (5.4 vs 4.9 mm; P = 0.21). The longissimus samples taken were of very similar size for the two groups at just over 1200 g (P=0.96), and the ultimate meat pH values (±SE) did not differ significantly between samples from stags (5.44±0.04) and hinds (5.45±0.03).

The results obtained in this study will be discussed not only with respect to the gender effect (stags versus hinds) on venison characteristics, but also with respect to broad differences between these results from venison and similar results for beef [4] and pork[5] obtained from measurements made on the same muscle in the same laboratory.

The beef data came from five breed and breed-cross groups with intramuscular fat levels ranging from less than 1% for Friesian bulls to about 8% for Wagyu-cross steers. Thus the levels were generally higher than for the venison, where it was significantly higher for samples from hinds than from stags (Fig. 1), but still less than 1.2%. As expected, the longissimus muscle from female New Zealand pigs had more intramuscular fat than the venison of the current study and those raised extensively had more than those raised intensively (3.36% vs 1.44%) [5].

Fig. 1: Differences between longissimus samples from red deer stags and hinds for intramuscular fat percent and vitamin E concentration (means±SE).



Muscle vitamin E levels (Fig. 1) were significantly higher for venison from hinds, which is possibly attributable to the higher intramuscular fat levels for that group, as vitamin E is a fat-soluble vitamin. For both groups the levels of between 0.4 to 0.6 mg/100 g were similar to those for beef from pasture-finished beef, and higher than would be expected from cattle on high concentrate diets [6], or for pigs receiving diets with low levels of vitamin E [5].

The iron content of venison at more than 3 mg/100 g did not differ significantly between the gender groups (Table 1) and was lower than the 3.82 mg/100 g reported for red deer venison by Drew and Seman [1], but was higher than levels in beef longissims [4], and much higher than iron in pork longissimus at less than 0.6 mg/100 g. The percentage of iron as haem iron was the same for samples from stags and hinds at 83.4% and similar to that for beef [4], but higher than that for pork at less than 60%.

Table 1 shows the effects of gender on a group of compounds that have been reported to have bioactive properties when included in the human diet [3], including coenzyme Q_{10} [7], taurine [8], and carnosine and anserine [9]. Coenzyme Q_{10} and taurine were present at higher concentrations in the muscle from hinds (Table 1), which suggests that the muscle had a higher proportion of red type I fibres as both these compounds are concentrated in mitochondria, but carnosine (not significantly) and anserine were also higher in muscle from hinds and these are usually lower in muscle with a higher proportion of red type-I fibres [3]. Carnosine levels were similar to those reported for beef and pork, but anserine levels were appreciably higher, and coenzyme Q_{10} concentrations were higher than for pork and for most of the beef samples evaluated [4].

Table 1
Means (±SE) for concentrations of selected nutrients in the longissimus muscle of red deer stags and hinds aged about 20 mo.

	Group			
	Stags	Hinds	Sign[1]	RSD[2]
Number of animals	10	10		
Total iron (mg/100g)	3.07	3.34	NS	0.31
Haem iron (% total)	83.4	83.4	NS	1.06
CoQ[3] (mg/100g)	2.82	6.29	***	0.98
Taurine (mg/100g)	18.1	37.1	***	9.4
Carnosine (mg/100g)	290.6	329.7	NS	46.5
Anserine (mg/100g)	188.2	251.4	***	31.3

[1] NS, $P > 0.05$; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.
[2] RSD = residual standard deviation
[3] CoQ = coenzyme Q_{10}

When expressed as a percentage of total fatty acids the differences between venison from hinds and stags could be largely attributed to the fact that intramuscular fat levels were significantly higher for the hind samples (Fig. 1). Thus the hind group had more myristic and palmitic acids but less stearic acid (Table 2), more palmitoleic acid but not oleic acid (Table 2), and less of several polyunsaturated fatty acids including most of the major *n-3* fatty acids (Table 3).

Table 2
Means (±SE) for concentrations of selected saturated and monounsaturated fatty acids in the longissimus muscle of red deer stags and hinds aged about 20 mo (% of total fatty acids).

	Group			
	Stags	Hinds	Sign[1]	RSD[2]
C14:0 (myristic)	2.37	4.02	***	0.92
C16:0 (palmitic)	17.58	25.21	***	2.88
C18:0 (stearic)	19.55	14.79	***	2.01
C16:1 (palmitoleic)	3.82	7.78	***	1.79
C18:1 c9 (oleic)	16.49	14.03	NS	1.91
C18:1 t11 (TVA[3])	0.68	0.73	NS	0.27
C20:1 (eicosenoic)	3.82	2.60	***	0.66

[1, 2] As for Table 1
[3] TVA = trans vaccenic acid

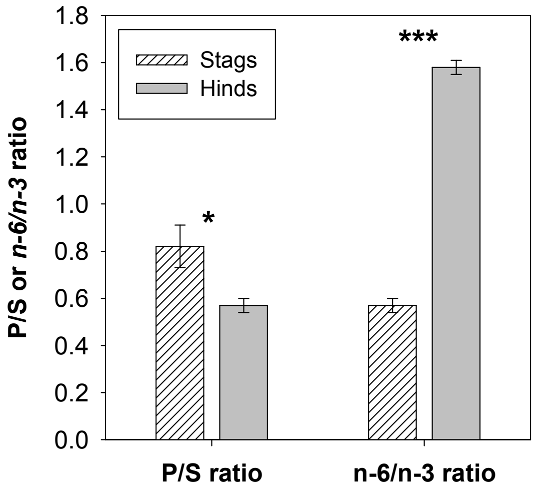
Table 3
Means (±SE) for concentrations of selected polyunsaturated fatty acids in the longissimus muscle of red deer stags and hinds aged about 20 mo (% of total fatty acids).

	Group			
	Stags	Hinds	Sign[1]	RSD[2]
C18:2 (linoleic *n-6*)	12.39	10.67	NS	2.44
C18:2 (CLA[3])	0.27	0.39	NS	0.14
C18:3 (α-linolenic *n-3*)	4.28	2.70	***	0.66
C20:4 (arachidonic)	4.32	3.91	NS	0.89
C20:5 (EPA[3] *n-3*)	3.97	2.85	**	0.82
C22:5 (DPA[3] *n-3*)	5.04	3.46	***	0.75
C22:6 (DHA[3] *n-3*)	0.91	0.66	NS	0.32

[1, 2] As for Table 1
[3] CLA = conjugated linoleic acids; EPA = eicosapentaenoic acid; DPA = Docosapentaenoic acid; DHA = docosahexaenoic acid.

These differences resulted in the P/S ratio being lower for the hind group, and the ratio of *n-6* to *n-3* polyunsaturated fatty acids being higher (Fig. 2). The higher ratio for the hind group at 1.6 was still low compared with the recommended ratio of 4:1 or less in the human diet[10]. The absolute amount of the long-chain *n-3* fatty acids at 9.92% for the stag group (Table 3) will equate to 99.2 mg in a 100 g serving of venison with 1% fat. This is low compared to recommended intakes of about 500 mg per day of EPA plus DHA made by various groups [11], and is much lower than levels from oily fish where these fatty acids often make up more than 20% of the total fat [12].

Fig. 2: Differences between longissimus samples from red deer stags and hinds for the P/S ratio and the *n-6/n-3* ratio of intramuscular fatty acids (means±SE).



Relative to beef and pork, levels of stearic acid were similar to beef but higher than for pork, while oleic acid levels were lower than for either beef or pork. Levels of CLA (Table 3) and its precursor (TVA) were lower than for beef, but higher than pork as expected. Other polyunsaturated fatty acids were at higher levels than found in beef. As with beef, the long-chain *n-3* fatty acid at highest concentration was DPA (Table 3), which contrasts with the situation for fish oils where it is usually at a much lower concentration than EPA or DHA [12].

IV. CONCLUSION

The results reported here confirm previous results in showing that venison from pasture-finished red deer is a low-fat product with levels of iron and long-chain n-3 fatty acids that are higher than comparable beef. Levels of most fatty acids, vitamin E and several compounds with bioactive properties including coenzyme Q_{10}, taurine, and carnosine, were similar to those found in beef, with the coenzyme Q_{10} levels slightly higher. Several significant differences between venison from males and females could be attributed to differences in intramuscular fat levels, but effects of gender and nutritional environment could not be clearly separated in this study, although all animals were finished on pasture.

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