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Venison and Other Deer Products

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Abstract

Game production is becoming an important industry in several countries. The main products from deer are meat, velvet antler, and leather. Venison from farmed deer has been shown to differ very little from wild-shot venison when the carcasses are of equal weight. The meat from young deer is extremely lean, having a fat content in the range of 5% to 10% of carcass weight and a very high lean/fat ratio. Electrical stimulation of carcasses will reduce the pH to 6.0 within 1 to 2 h compared with 6 h in unstimulated carcasses. Chilled venison, when vacuum packaged and held at −1° C, had a shelf life in excess of 12 weeks. Controlled atmosphere packaging did not further improve shelf life or product quality. Velvet antler is a valuable deer product used in oriental medicine for treating a wide range of human conditions. The product is often given to children as a protection against problems such as influena. Deer skin leather is a particularly durable product which is now being used in a wide range of fashion garments.

Key words: Carcass, deer, deer skins, fat, meat quality, meat packaging, velvet antler, venison

Introduction

The role of animal products in the human diet has been the subject of a voluminous literature in recent years. The National Research Council (NRC 1988) stated that "Animal products contribute more than one-third of the calories and between a third and all of the other major nutrient in the food supply." Red meat comprises almost half of the energy and protein contributed by animal products.

World trade in game meat products is now greater than 30 000 tons per year (Luxmoore 1989), yet little of that will be from farmed or closely managed animals. New Zealand is one of the few countries to have recently established the full domestication of deer for farming, and the production of ranched venison is expected to increase from about 4000 tons in 1989 to 20 000 tons by the mid-1990s (Fennessy and Taylor 1989). Commercially, the deer is a multipurpose animal providing venison to an international market, velvet antler for the oriental medicine trade and other less important products such as hides, pizzles, ligaments, and teeth.

The farming of deer in low input systems for sustainable agricultural production should have a favorable future in a society which is becoming increasingly sensitive to environmental pollution, animal manipulation, and feed additives.

Venison

Venison or deer meat can be derived from feral or farm-raised deer, and from several different species or strains of deer. The quality of the product may be greatly influenced by commercial treatment such as pre- and postslaughter handling, packaging, storage, transport, and cooking preparation. If science had been commissioned to produce a "designer" red meat that had all the best attributes of our traditional farm animals and none of the perceived bad features, then the successful result would have been something remarkably like venison.

Carcass Characteristics of Feral and Farmed Deer

Differences in carcass composition between some feral ungulates and the same species in domestication were considered by Crawford (1968), who concluded that the marked differences in fatty acid composition were dietary in origin. Carcasses from feral, grass-fed, and feedlot-raised red deer (*Cervus elaphus*) in New Zealand were analyzed for differences in composition. Figure 56.1 indicates that variation in carcass fatness was mainly a function of carcass weight and non environment. Because there were no significant environmental differences the following common regression equation was calculated (71 animals ranging in weight from 23.7 kg to 143.6 kg and from 1 to 9 years of age):

$Y = 0.191X - 2.49$ where $Y = \%$ carcass fat and $X =$ carcass weight (kg), the SE of the slope and intercept were 0.008 and 0.58 respectively and $r^2 = 0.89$.

The feral deer certainly have less fat than farmed or feedlot-raised deer because the feral deer were much smaller at equal age. In relation to carcass weight both feral and farmed deer in their first winter (6 month of age) are fatter than expected. This may have been due to lack of rumen development and reliance on milk as a

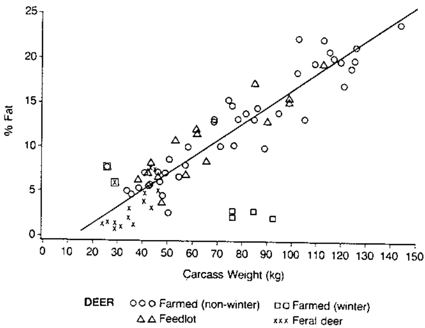

FIGURE 56.1. Carcass weight and fatness in red deer stags.

TABLE 56.1. Composition of leg meat from feral and farmed red deer ($n = 6$ per group)

	Feral	Farmed	
Age (months)	27	12	27
Carcass weight (kg)	43.1	40.8	75.7
Lean meat (g/100 g)	95.6	95.6	88.0
Fat (g/100 g)	3.3	3.3	10.9
Minerals (g/100 g)	1.1	1.1	1.1
Saturated and mono-unsaturated fatty acid (S) (g/100 g)	2.8	3.0	10.6
Polyunsaturated fatty acids (P) (g/100 g)	0.5	0.3	0.3
Tryglycerids/phospholipids	3.4	5.6	17.8
P/S ratio	0.178	0.100	0.028

major dietary component. Deer are very seasonal animals in their growth patterns and show marked mobilization of fat reserves during the breeding season (Drew 1985). The very low winter carcass fat content (Fig. 56.1) is typical of the very limited adipose tissue stored in deer during the winter season. The slope of the regression line indicates that 1 kg of carcass gain comprises 0.19 kg fat, a figure that is a little lower than that published by Drew (1985). Rate of fat deposition in deer is less than half of that shown in sheep by Fennessy and Greer (1982).

There are substantial differences between the meat composition of 27-month-old feral and farmed animals, but this is a function of differences in carcass weight (Table 56.1). Twelve-month-old farmed animals are very similar in weight to 27-month-old feral deer, and their carcass compositions are almost identical. There are some differences between the groups of deer in polyunsaturated (P) fat levels and these are more fully documented by Manley and Forss (1979). Feral animals tend to be higher in P fatty acids than farmed (Table 56.1). Most of the P is in the phospholipid fraction, and although environmental effects were present, they were not quantitatively important. Because of the substantial adipose tissue depot in the 27-month-old farmed deer, their P:S ratio is about one-sixth of that in feral deer.

Possible differnces in the taste of venison derived from feral, farmed, and feedlot deer were researched by Forss et al. (1979). These researchers found that differences between carcasses from the same feed environmental were substantial, and generally concluded that, "it is unlikely that meat from deer not older than 27 months and on different diets would be distinguished when eaten." Brittin et al. (1981) found that beef was juicier, much higher in fat and of similar tenderness, when compared with meat from feral male deer.

Farmed Deer Carcass Composition

Carcass characteristics of different speies and strains of farmed, entire, male deer are compared with Aberdeen Angus cattle in Table 56.2. All deer less than 26 months of age have a separable lean content which ranges from 72.7% to 76% of the carcass weight. A comparable figure for cattle is 62%, although varition will be wide between breeds and sexes. Seman and McKenzie-Parnell (1989) quoted figures of separable lean (% hot carcass weight) that ranged from 48.0% in pork to 59% for beef, veal, and chicken. Mutton and lamb were intermediate. Mature deer get very fat at the end of summer, and the lean content is reduced to 60%–70%. In contrast, the deer fat levels are low in animals less than 2 years of age.

TABLE 56.2. Farmed deer carcass composition

Species	Age	Weight (kg)	Carcass weight			Lean/fat	Lean/bone
			Lean (%)	Fat (%)	Bone (%)		
Fallow[a]	13–25 months	24–40	73.9	9.1	13.6	8.1	5.4
Red	26 months	62.6	72.7	7.0	20.3	10.4	3.6
	9 and 10 years	129.5	70.9	14.2	14.9	5.0	4.8
NZW[b]	26 months	83.0	72.7	4.2	23.5	17.3	3.1
	4 and 5 years	115.3	66.8	14.7	18.5	4.5	3.6
Hybrid (NZW/red)	26 months	78.0	73.8	5.4	22.0	13.7	3.3
	4 and 5 years	115.5	60.9	19.7	19.4	3.1	3.1
Hybrid (elk/red)	11 months	67.6	76.0	4.7	19.3	16.2	3.9
Angus cattle[c] (bull)	2 years	250.0	62.0	21.5	14.0	2.9	4.4

[a]Gregson and Purchas (1985)
[b]From an NZ population of mixed elk/red breeding
[c]Maiga (1974)
NZW, New Zealand wapiti

Carcass bone content in cattle is generally lower than in deer with the exception of fallow deer. Bone content in carcasses of traditionally farmed species can range from 17% in lamb to 28% in veal with beef, pork, and chicken in between (Seman and McKenzie-Parnell 1989). The lean/fat ratio, as a measure of edible soft tissue, shows that young deer are very high when compared with beef. Calculations from the data of Seman and McKenzie-Parnell (1989) yield lean/fat ratios of 1.6, 1.9, 2.6, 3.2, 3.9, and 5.1 for mutton, pork, beef, lamb, chicken, and veal, respectively. All these figures are much lower than those for young deer which range from 8.1 to 16.2. Two types of young deer stand out in Table 56.1 as extremely good for carcass production. The first is fallow deer (*Dama dama*) with a low bone content and very high lean/bone ratio. The other is the elk (*Cervus elaphus canadensis*)/red hybrid, which at only 11 months of age can produce a 68 kg carcass with 76% lean, 4.7% fat, and a bone content of 19%.

Factors Affecting Venison Quality

The two most important features of meat are its tenderness when it is eaten and its color when it is purchased. Venison quality has been the subject of recent significant work.

Electrical Stimulation and Meat Quality

Postslaughter electrical stimulation of carcasses is now widely used to prevent toughness in meat that is caused by cold or thaw shortening. Experiments from Chrystall and Devine (1983) and Drew et al. (1988) have shown that if nonstimulated deer carcasses are subjected to 0° to 2° C temperatures within 2 h of slaughter then tough meat will be produced. The critical pH in lamb muscle required to avoid cold shortening is about 6.0 (Chrystall et al. 1984). In venison experiments it took at least 6 h at 10° C to achieve this pH in nonstimulated carcasses compared with 1 to 2 h when stimulation was used. When carcasses were held at 10° C for 2 h after slaughter then 0° C for a further 22 h, electrically stimulated carcasses were 50% more tender than nonstimulated ones. It is possible to substitute carcass storage at an elevated temperature (e.g., 10° C) for electrical stimulation in order to achieve tender venison, but this delays carcass cutting where regulations require a deep bone temperature of not higher than 7° C before cutting is permitted.

Skinning and Evisceration

Carcass contamination during processing will shorten the shelf life of the meat, and deer hair is frequently found on skinned carcasses. The inverted deer dressing system developed by A.W.A. Milmech in New Zealand (Drew 1989), involves holding the carcass on a rail by the front legs and mechanically pulling the skin from the head and over the back legs. The procedure prevents hand or knife contact with the high-value saddle/hind leg part of the carcass. There is considerable varition in the microbiological loading on venison carcass at different plants (Table 56.3). The Invermay plant uses inverted dressing while the other two use traditional procedures. Although all average counts are low and all plants have worked efficiently, the range in microbial counts is much greater from the commercial plants than from Invermay. Operator skill has a major influence in the quality from traditional plants but less so when inverted dressing is used. The bacteriological loading on the farmed deer carcasses compared very favorably with beef where bacteriological counts of 500 to 1000/cm² are common (Nottingham and Wyborn 1975) and feral venison can have more than 10000/cm² (Sumner et al. 1977).

Packaging

Venison from New Zealand is mainly vacuum packed when transported as a chilled product

TABLE 56.3. Microbial counts (expressed as colony forming units/cm² with range in parentheses) from farmed deer carcasses processed at three New Zealand plants

Slaughter plant	Carcass site: Shoulder	Middloin	Leg
Invermay	1 (0–11)	1 (0–24)	1 (0–16)
Plant B	33 (0–53000)	30 (0–2000)	ND
Plant C	10 (0–10000)	21 (0–158000)	7 (0–2000)

ND, not determined

Modern technologies such as controlled atmosphere packaging have been researched using venison (Seman et al. 1988, 1989). Table 56.4 shows the effect of the packaging system on venison quality when the product was stored for up to 18 weeks at 0° C. There was a trend towards increasing tenderness with length of storage in all treatment, but this was quantitatively small and all samples were quite tender. Color stability of displayed meat is an important matter, and vacuum-packed venison was found to be slightly better than other storage systems, although all packaging systems produced meat with a very short display life after 18 weeks of storage. Venison color has been shown by Stevenson et al (1989) to be very highly correlated with acceptability. Since venison is rather dark in color due to the high iron content, some consumers will see it as unattractive. Color deterioration with increasing storage time will exaggerate that perception. Relatively long periods of storage with venison do not seem to have much effect on odor (Table 56.4) and this may be due to the very low fat levels and, therefore, a reduced tendency towards rancidity.

TABLE 56.4. Packaging system and storage time as they influence venison quality (data from Semen et al. 1988)

	Storage time at 0° C (weeks)			
	1	6	12	18
Venison tenderness (kPa/cm)				
Vacuum	27.8	26.1	25.0	25.9
CO_2-UHB[a]	32.1	25.3	26.9	25.7
CO_2-foil[b]	24.4	26.2	26.4	25.9
Color stability[c]				
Vacuum	5	4	3	2
CO_2-UHB[a]	5	3	2	1
CO_2-foil[b]	3	3	2	2
Odor[d]				
Vacuum	3	3	2	2.5
CO_2-UHB[a]	3	3	2.9	2.2
CO_2-foil[b]	3	3	3	2

[a] CO_2 flush ultra-high-barrier film
[b] CO_2 flush polyester aluminium foil laminate
[c] Days of display to reach color acceptability score of 2 (purchase with reservations)
[d] Scored on 3-point scale: 3, no off odors; 2, off odor—not objectionable; 1, off odor—objectionable

Shelf Life of Chilled and Frozen Venison

Drew and Fennessy (1986) found that there was a considerable decrease in toughness of vacuum-packed venison leg and loin cuts during the first 6 weeks of storage at 1° C but no change thereafter (Fig. 56.2). Changes in tenderness during the first 6 weeks of storage do differ from what is presented in Table 56.4 with the latter showing only small changes from weeks 1 to 6 in tenderness. This difference is likely to be due to differences in storage temperature and the time from packaging to first sampling. In practical terms, well-prepared and packaged chilled venison does not deteriorate noticeably over 12 weeks of storage, but undesirable changes begin to occur after that time. The shelf life of frozen venison is long if it is well-prepared and packaged. Storage at −12° C and −18° C of whole muscle cuts and "retail-ready" portions of venison for up to 28 months has few measurable effects on product quality, except that there was an indication of noticeable rancidity in "retail-ready" portions packed in permeable film after 8 months of storage (J.M. Stevenson et al., unpublished data).

Nutritive Value of Venison

Nutrition-related health problems arise in affluent societies from over consumption of fat, saturated fatty acids, and cholesterol (NRC 1988). Red meat is a major source of these items,

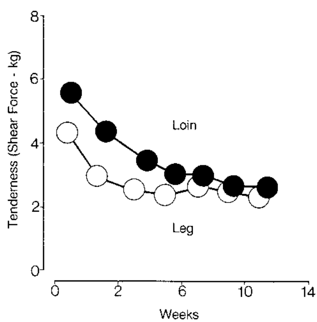

FIGURE 56.2. Changes in venison tenderness with holding time at 1° C.

TABLE 56.5. Nutrient composition per 100 g of untrimmed venison meat from red deer (data from Drew and Semen 1987)

	Loin	Leg
Protein (g)	24.7	23.8
Fat (g)	3.3	3.0
Water (g)	70.8	71.2
Minerals (g)	1.4	1.9
Energy (kJ)	545	519
Cholesterol (mg)	66	74
Calcium (mg)	5	3
Magnesium (mg)	25	29
Sodium (mg)	51	47
Potassium (mg)	352	367
Copper (μg)	190	216
Iron (μg)	3820	3900
Zinc (μg)	2820	2510
Selenium (μg)	2.2	2.2

Mean carcass weight, 69.4 kg; $n = 10$

and consumers are seeking information on nutrient contents of many meats. Drew and Seman (1987) have studied venison nutrient content and compared it with meat from traditional livestock. Venison loin and leg are extremely high in protein and iron while being very low in fat, energy, and cholesterol (Table 56.5). It clearly ranks as a preferred health food for the 1990s.

Breeds of Farmed Deer

Fallow, red, wapiti, hybrid, and to some extent axis deer are all farmed for venison. Fallow deer mature rapidly and need to be slaughtered as yearlings if overfatness is to be avoided. Overfatness can also be a problem in red deer if the animals are slaughtered in summer at more than 2 years of age. Wapiti and red/wapiti hybrids mature more slowly and do not usually show much summer fat deposition until 3 years old and older (Drew and Hogg 1990). A wide variety of cervids will hybridize and produce fertile offspring (Dratch and Fennessy 1985). The use of a wapiti bull mated to a red deer hind will produce a large, fast-growing calf with excellent carcass characteristics at an early age (Pearse 1988). The hybrid bulls are now in great demand in New Zealand as sires over red hinds to produce one-quarter wapiti progeny. These animals will become important venison producers in future years. The half-bred wapiti/red animal at an early age (11 months) has a bigger and better carcass than a 2-year-old red deer (Table 56.6). Lean content of 76% is extremely high, fat is very low and the hybrid does not appear to have a large bone content.

Velvet Antler

The partly grown and immature antlers from several species of deer are a very valuable product in traditional oriental medicine. Kong and But (1985) have comprehensively reviewed the products of deer for medicinal purposes. New Zealand developed a sophisticated velvet antler industry because of its good internal communication, a strong industry structure, and a business community prepared to invest in the cooking/drying technology required to produce top-quality velvet antler. Prices to farmers have fluctuated considerably since 1980, but the return has never been less than about $60US/kg for the best grade. Since red deer stags will produce 2[illegible] kg/year, this represents a good return to the farmer.

The use of velvet antler in a medical practice has been described by Yoon (1989) who says that he gives about 70% of his velvet antler to children in helping to prevent such problems as influenza

TABLE 56.6 Tissue carcass composition of 26-month-old red stags and 11-month-old elk/red hybrid stags expressed as percentage of carcass weight

	Lean (%)	Fat (%)	Bone (%)
Red deer (mean carcass weight 63 kg; $n = 53$)	72.7	7.0	20
Elk/red hybrid (mean carcass weight 68 kg; $n = 8$)	76.0	4.7	19

The product is used in small doses (e.g., 4 g) and usually with herbal medicines. Extracts of velvet antler are also used as acupuncture injections having special effects on problems such as sciatic neuritis, impotence, shoulder pain, neck stiffness, and the after-effects of paralysis. Extracts of velvet antler in the form of pantocrin and rantocrin have been made in the USSR for a very long time and are used in human medicine.

The New Zealand Game Industry Board has established a good working relationship with the Korean Pharmaceutical Traders Association and now has a comprehensive velvet antler grading system in place to allow buyers to establish their preferences. Strict procedures are in place to see that analgesic drugs are used when velvet is cut from stags so that they feel no pain. The procedure must be done under the supervision of a veterinarian. After removal, the velvet is cooled, wrapped and frozen, pending sale or drying for further processing. Because of the high price currently being paid for velvet antler, many New Zealand deer farmers are holding stags back from slaughter in order to take a velvet antler cut; therefore, export volumes are going up rapidly.

Deer Skins

Deer leather from well-prepared skin produces a particularly high quality leather suitable for fashion garments. The strength of the leather (60–90 N/mm) is much greater than that of sheep leather (25–35 N/mm). Therefore, deer skin can be processed to a very thin leather (e.g., 0.4 mm) which is excellent for high fashion garments (Clark and Webster 1985). Skin can be damaged during the yarding and holding of animals preslaughter. Flailing feet and hard antlers are commonly seen in the deer yard and these do physical damage to skins which precludes their use for top-quality leather garments. As deer farming grows around the world, the quantity and quality of deer skins should become increasingly important in the making of leather goods.

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