VENISON AND VELVET PRODUCTION FROM RED AND HYBRID DEER BY ONE YEAR OF AGE

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ABSTRACT

BYENG-RYEL MIN, Department of Animal Science, Massey University, Palmerston North, **New Zealand**. THE EFFECTS OF GRAZING CHICORY (*Cichorium intybus*) AND LOTUS CORNICULATUS UPON VENISON & VELVET PRODUCTION BY ONE YEAR OF AGE.

A grazing experiment was conducted at Massey University Deer Research Unit, Palmerston North, New Zealand during 1995, to study the effects of grazing chicory (*Cichorium intybus*), *Lotus corniculatus* and perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) pasture upon the growth, voluntary feed intake (VFI), venison and velvet production of red and hybrid (0.75 red;0.25 elk) deer from weaning to slaughter at one year of age. The animals were randomly allocated to graze either chicory, lotus or pasture and grazed these forages during autumn and spring using a rotational grazing system, with each group balanced for genotype and sex. All groups were joined to graze pasture during winter, when chicory and lotus were dormant.

1. Few animals attained the target slaughter weight (50kg carcass or greater) when grazing pasture and spiker velvet antler weight was low at approximately 0.2 kg per stag.

2. In this study the greatest advantages obtained for specialist forages were for chicory. Carcass weight of deer grazing chicory was higher than for deer grazing pasture, due mainly to increasing autumn LWG and dressing-out percentage at slaughter, with a smaller response in spring LWG. The largest carcass weights were consistently obtained from hybrid stags grazing on chicory, with values for red deer and hybrid stags being 56.0 and 59.3 kg when grazed on chicory and 48.6 and 53.3 kg respectively when grazed on pasture. Chicory had a higher organic matter digestibility (OMD) and VFI than pasture during autumn but similar values in spring, accounting for its autumn

growth stimulation. Carcass subcutaneous fat depth (GR) was higher for deer grazing chicory than pasture, but after being adjusted to equal carcass weight, there was no difference in GR measurement.

Relative to deer grazing on pasture, grazing on chicory increased total spiker velvet antler production (323 v 225 g/stag), by advancing the dates of pedicle initiation (18 days), velvet antler initiation (24 days), and first velvet cutting (17 days) and increasing the rate of velvet antler length growth. Initiation of velvet growth was correlated with liveweight, with each 10 kg increase in liveweight advancing the dates of pedicle initiation, commencement of velvet growth and first velvet cutting by 10, 18 and 13 days respectively. Correction of the data to equal liveweight removed a component of the advancement produced from feeding on chicory, but an effect still remained due to chicory feeding *per se*. It was concluded that grazing chicory not only increased carcass weight (especially in hybrid stags), but also increased velvet antler production. This was achieved by increased VFI and increased OMD of chicory in autumn, relative to deer grazing pasture, and probably by increased absorption of protein and minerals in deer fed chicory.

3. OMD of lotus was higher than that of pasture during autumn, but not in spring. The OMD of either chicory or lotus showed little change between seasons, but pasture changed with the season, being of lowest OMD in autumn and highest OMD in spring.

4. Responses to deer grazing lotus were limited by the reduced number of grazing days that could be achieved, due to problems in lotus establishment. In spite of these problems, grazing lotus (48 gCT/kg OM) did increase the LWG of stags during autumn (248 v 176 g/day) and increased the efficiency of growth in spring, with LWG being similar to deer grazing pasture, but VFI being lower (1.53 v 2.00 kgOM/day) for lotus compared to pasture. Although deer grazing lotus had a similar carcass weight compared to deer grazing pasture, dressing-out percentages of deer grazing lotus were higher than that of deer grazing pasture (56.4 *v* 53.2 %). The carcass GR tissue depth of deer grazing lotus had similar values compared to pasture. There was no interaction between forage and genotype for carcass weight and dressing out percentage. Stags grazing lotus did not show any advancement in dates of pedicle initiation, velvet antler initiation and weight of velvet production compared to stags grazing pasture.

5. Total condensed tannin (CT) concentration in lotus was 48 and 13 g/kgOM in hand plucked and oesophageal fistulae (OF) extrusa samples respectively. Most CT in hand plucked lotus samples was extractable, with much smaller amounts being protein-bound or fibre-bound. Extractable CT was not detected in lotus OF extrusa samples, and the concentration of protein-bound and fibre-bound CT remained similar to hand plucked samples. Therefore, after chewing during eating, the extractable component of CT in lotus feed could not be extracted and detected by the Butanol/HCl analysis methods and may have been bound to deer salivary proteins. Total CT in both hand plucked and OF extrusa samples was 3.1 v 5.8 g/kgOM for chicory and 0.3 v 1.5 g/kgOM for pasture. As a result, chewing (in OF samples) did not reduce the CT content of pasture or chicory. This may be due to the low concentration of extractable CT (and high proportions of bound CT) in these forages, which may have limited access for the deer salivary CT-binding proteins.

6. Overall it was concluded that chicory was of very high feeding value (FV) and had excellent nutritional advantages for increasing deer production. However, crops of chicory need to have specialised grazing management to increase persistency. New chicory cultivars need to be selected to increase persistency and to reduce reproductive stem formation during summer. Effects of protein supply on initiation of pedicle and velvet antler development in weaner stags grazing fresh forages also needs to be studied.
The small responses obtained in the present study give some indication that the CT content of *Lotus corniculatus* may have a number of values for improving the efficiency of growth in young deer. Further experiments are needed in this area.

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LIST OF ABBREVIATIONS

ADF	acid detergent fibre
cm	centimetre
CT	condensed tannin
D	digestibility
DM	dry matter
DMI	dry matter intake
DOMI	digestible organic matter intake
EAA	essential amino acids
FO	faecal output
FOR	fractional outflow rate
FV	feeding value
GR	a measurement of total soft tissue depth over the 12th rib at a point 11 cm from the carcass line
GIB	Game Industry Board
h	hours
ha	hectare
k_f	efficiency of utilisation of ME for fattening
k_g	efficiency of utilisation of ME for growth
k_l	efficiency of utilisation of ME for lactation
k_m	efficiency of utilisation of ME for maintenance
kg	kilograms
Ltd	limited
LWG	liveweight gain
ME	metabolisable energy
min	minute
MJ	megajoule
N	nitrogen
NAN	non-ammonia nitrogen
ND	not determined
NDF	neutral detergent fibre
NEAA	non-essential amino acids

NH3	ammonia
NV	nutritive value
NZ	New Zeland
OM	organic matter
OMD	organic matter digestibility
OMI	organic matter intake
SD	standard deviation
SE	standard deviation
t	tonne
UK	United Kingdom
USA	United States of America
VFA	volatile fatty acid

CHAPTER 1

LITERATURE REVIEW

1. INTRODUCTION

This review, based on published literature, summaries data on the classification, distribution, seasonality, feeding behaviour, deer farming, nutrient requirements, forage feeding value and venison production from farmed deer. A comparison of tropical and temperate deer, and a limited comparison with sheep and other domesticated livestock, will also be made. Finally, detailed consideration is given to venison production using special forage diets such as chicory and *Lotus corniculatus*.

1.1. CLASSIFICATION AND DISTRIBUTION OF TEMPERATE AND TROPICAL DEER

There are 42 species (Whitehead, 1993) of deer worldwide, grouped into 16 genera which have adapted to a wide variety of environments from the Arctic circle to the tropics (Table 1). The capacity to adapt to these environmental changes and the resulting effects on deer are reflected in their biology at species, subspecies and population levels (Tudge, 1993).

Deer belong to the order Artiodactyla (ungulates), suborder Ruminantia and family Cervidae (Van Soest, 1994). The deer of the world are divided into two families MOSCHIDAE (non-antlered artiodactyls) and CERVIDAE (antlered artiodactyls), which are further divided into seven sub-families (Table 1;Whitehead, 1993). Family Cervidae contains 16 genera which consist of about 41 species and about 196 subspecies (Whitehead, 1993), with wide geographical and ecological distribution in their native ranges and containing the most popular farmed species. Red deer, wapiti and fallow deer are farmed in significant numbers, and rusa, sika, sambar and Pere David's deer are also farmed, but to a much lesser extent (Haigh and Hudson, 1993; Wilson, 1991).

Of the 42 existing species of deer, 15 species live primarily in temperate and cold zones (30^{o}- 80^{o} latitude). Temperate species include reindeer/caribou, musk, huemul, and pudu deer. Twenty five species live in the tropical and subtropical zones (0^{o}-30^{o} latitude) including sambar, swamp, Elds, axis (chital), rusa, hog, muntjac, white-tailed, marsh, pampus, brocket, huemul, and pudu (Lincoln, 1992). Although most species can be clearly defined as adapted to either a tropical/subtropical or temperate/cold climate, there are some species such as the American white-tailed deer whose natural range spans both tropical and cold climates (Woodford, 1993).

Tropical species are mostly concentrated in Southern Asia, with sambar being the largest and most widespread in its distribution (Whitehead, 1993). The most successful introductions of axis (chital) deer have been to Hawaii, Texas and Argentina (Whitehead, 1993). The main contributing factor in the successful naturalization of axis deer in Hawaii may be that the latitude of 19^{o} and 22^{o} N is the same latitude as central India.

New Zealand (NZ), Australian and British experience has shown that deer have a suitable temperament for farming, can be easily managed and handled in groups, reproduce well in captivity, and have diseases that can be effectively controlled. Cervidae have a history of centuries of economic association with man in many countries as food suppliers, for recreation, as producers of hides and as a source of traditional medicinal products.

Table 1. World distribution and status of 42 species (39 species for Klein, 1992) in 17 genera

Family/subfamily Common name	Scientific name	Distribution natural (introduced & status)
CERVIDAE		
HYDROPOTINAE		
Water deer (Chinese water-deer)	*Hydropotes inermis*	China, Korea (England)
MUNTIACINAE		
Indian muntjac	*Muntiacus muntjac*	India, Sri Lanka, Burma, SW China, SE Asia including Borneo (England)
Reeve's muntjac	*M reevesi*	E. China, Formosa (England)
Black muntjac	*M. crinifrons*	C. China (R)
Fea's muntjac	*M. feae*	Thailand, S. Burma (E)
Roosevelt's muntjac	*M. rooseveltorum*	N Vietnam
Tufted deer	*Elaphodus cephalophus*	South & SE China, NE Burma
CERVINAE		
Fallow deer	*Dama dama*	Europe, Asia Minor, Iran (Australia, NZ)
Chital (Axis deer	*Axis axis*	India , Sri Lanka (Australia, Hawaii)
Calamian deer	*A.. calamianeusis*	Calamian Is.-Philippines (T)
Thorold's deer	*Cervus albirostris*	Tibet (R)
Swamp deer	*C. duvauceli*	N & C India, S Nepal, Scandinavia, Europe, N Africa, Asia, Minor, Tibet, Kashmir, Parkestan, Afghanistan, (Australia, NZ) (E)
Red deer	*C. elaphus*	Sweden, Norway, Scotland, Europe, Spain, Corsica & Sardinia, North Africa, Asia, Kashmir, China, Tibet, Russia, Afghanistan
Wapiti	C. *canadensis*	W North America, Tien Shan, Mts to Manchuria & Mongolia, Kansu, China (NZ)
Eld's deer	*C. eldi*	E India, Thailand, Vietnam, Hainan Is., Burma (E)
Sika deer	*C. nippon*	Japan, Vietnam, Taiwan, Manchuria, N & SE China, Korea (NZ, United states, British Isles) (E)
Rusa deer	*C. timorensis*	Indonesian Archipelago (Australia, NZ, Fiji, New Guinea)
Sambar	*C. unicolor*	SE Asia- Philippines to Sri Lanka (Australia, NZ)
Pe're David's deer	*Elaphurus davidiensis*	China (England) (E)
ODOCOILINAE		
Mule deer & Black-tailed deer	*Odocoileus hemionus*	W North America, Central (E) America (Hawaii)
White-tailed deer	*O. virginianus*	N, C & S America to Peru & Brazil, (NZ, Finland)
Roe deer	*Capreolus capreolus*	Europe, Asia Minor, Siberia, N Asia,Manchuria, N China, Korea.
Marsh deer	*Blastocerus dichotomous*	C Brazil & N Argentina (E)
Pampas deer	*Ozotoceros bezoarticus*	Brazil, Argentina, Paraguay, Bolivia (E)
Chilean huemul	*Hippocamelus bisulcus*	Chile, Argentina (V)
Peruvian huemaul	*H. antisensis*	Peru, Ecuador, Bolivia, N Argentina (T)
Red brocket	*Mazama americana*	C & S America-Mexico to Argentina
Little red broket	*M. rufina*	Venzuela, Ecuador, SE Brazil
Dwarf brocket	*M. Chunyl*	N Bolivia, Peru
Southern pudu	*Pudu pudu*	Chile, Argentina (E)
Northern pudu	*P. mephistophiles*	Ecuador, Peru, Columia (U)
ALCINAE		
Moose Elk	*Alces alces*	N Europe, Siberia, Mongolia, Manchuria, (NZ), Alaska, Canada, N USA
RANGIFERINAE		
Reindeer/caribou	*Rangifer tarandus*	Scandinavia, Svalbard, USSR, N China, Alaska, Canada, Greenland (S Georgia, Scotland)
MOSCHIDA		
MOSCHINAE		
Siberian musk deer	*Moschus sibiricus*	C & E Siberia, N Mongolia, Korea, Sakhalin
Southern musk deer	*M. moschiferus*	C & SW China, N India Pakistan, Tibet (V)
Berezovski musk deer	*M. berezovskii*	Szechwan & Kansu, China (T), W Nepal

Status; R; rare, E; endangered, T; threatened, V; vulnera, U; undetected. From Whitehead, 1993; Klein, 1992

1.1.1. HYBRIDIZATION

Recent research in NZ has focused on the reproductive manipulation of deer farming through hybridization, inducing twinning, altering sex ratios and advancing the calving season (Pearse, 1992).

Hybridization between deer of the same species but different subspecies, has frequently been recorded among wild or feral populations such as red deer with wapiti in NZ, and elsewhere (British Isles, Australia and USSR). There have also been attempts to exploit the potential of hybrid some other species of deer for farming such as Pere David's deer x red deer in NZ (Fennessy and Mackintosh, 1992), the white-tailed deer in North America, the roe deer in Europe, and both rusa and chital deer in the southern states of Australia (Woodford, 1993). Hybridization between a sambar stag and rusa or red hinds (this new breed has been named "Samson" deer by Whitehead, 1993) may be of potential significance for commercial deer farming in NZ and some other countries. A summary of results of successful hybridization between species and genera is shown in Table 2.

Table 2 Summary of results of successful hybridization between species (Whitehead, 1993).

Between genera	Between species
Axis x White-tail deer	Red x Wapiti
Axis x Red deer	Hangul x Sika deer
Axis x Swamp deer	Sambar x Rusa deer
Hog x Roe deer	Philippine spotted x Basilan deer
Hog x Fallow deer	Indian Muntjac x Reeves's Muntjac
Red x Pe're David's deer[1]	White tail x Mule deer
	N White tail x Columbian blacktail
	Red x Sambar deer

[1] Fennessy & Mackintosh, 1992; Krzywinski, 1993.

1.2. SEASONALITY OF TEMPERATE & TROPICAL DEER

Temperate deer have very strong seasonal patterns of voluntary feed intake (VFI), body growth rates, metabolic rate and reproductive activity (Barry *et al.*, 1991).

To adapt to a changing temperate climate and seasonal variation in the quality and quantity of forage available to them, temperate deer have evolved a pronounced yearly seasonal physiology with a neuroendocrine mechanism which relays effects of changes in day length (Suttie & Corson, 1991; Lincoln, 1992). Although the species adapted to tropical and subtropical climates have a less marked seasonal physiology, they still show some seasonality (Sadleir, 1987; Mylrea, 1991; Semiadi *et al.,* 1995b).

1.2.1. VOLUNTARY FEED INTAKE

Forage intake is a function of digestibility, which primarily reflects reticulo-ruminal rates of fermentation and passage characteristics in the gut (Meissner and Paulsmeier, 1995). Digestibility also has a major influence, especially on the M/D value (MJ ME/kg DM) of pasture (Poppi *et al.*, 1987). With forages intake is often expressed per unit of metabolic body weight ($BW^{0.75}$) (Demment and VanSoest, 1985).

In temperate deer there is a markedly seasonal pattern of voluntary feed intake (VFI), with the highest intakes shown in spring and early summer and the lowest intakes in winter (Domingue *et al.*, 1991 a; Semiadi *et al.*, 1995b), as shown for red deer in Fig. 1a. Food intake increased briefly, before declining again in mid winter.

A decline in VFI of 32% in red hinds and 57% in red stags coincided with the breeding season in autumn (Semiadi *et al.*, 1995b), even when a high quality pelleted feed was provided *ad libitum* (Fennessy and Milligan, 1987). This was possibly due to high plasma testosterone concentration during the rut in stags (Suttie *et al.*, 1987, Semiadi *et al.*, 1995b).

This seasonal pattern of VFI is pronounced in two year old and older stags (Fennessy and Milligan, 1987) and it also occurs in younger males and to a lesser extent in females (Suttie *et al.*, 1989). The timing of these cycles can be adjusted by changing photoperiod (Suttie *et al.*, 1992) and by administration of melatonin (Asher *et al.*, 1988).
However, sambar deer showed weak seasonal patterns of VFI (Fig. 1a) with maximum feed intake in autumn and minimum values in spring. The period of low VFI in sambar was longer than in red deer. Grimaud *et al.,* (1994) reported that VFI in rusa deer in New Caledonia was highly correlated among animals of both sexes and was not influenced by daylight duration.

Similar seasonal variation of food intake has been recorded in other Cervids such as mule deer (Wood *et al.*, 1962), reindeer (McEwan and Whitehead, 1970), moose (Gasaway and Coady, 1974), roe deer (Drozdz *et al.*, 1975), and wapiti (Jiang and Hudson, 1992). Food intake for wapiti in winter pen trials were equal to, or below maintenance requirements (32 g/kg$^{0.75}$/day in herbage and 37 g/kg$^{0.75}$/day in pellets of digestible dry matter). Intakes increased threefold on spring pasture to 105 g/kg$^{0.75}$/day, and the animals rapidly gained weight (Jiang and Hudson, 1992).

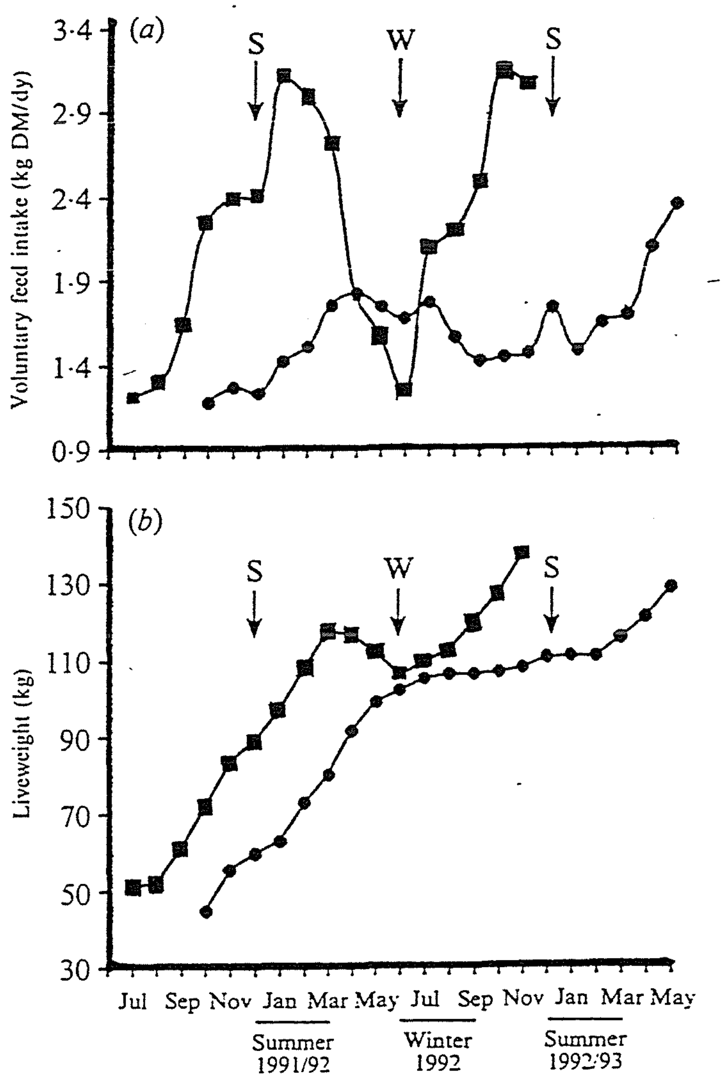

Figure 1 Seasonal changes in (a) voluntary feed intake (kg DM/day) and (b) liveweight in young red deer stags (temperate) (■) and sambar deer stags (tropical) (•) individually fed a pelleted concentrate diet under indoor conditions. The diet contained 29 g N/kg DM and 12.2 MJ ME/kg DM. Red deer were aged 8 months and sambar deer 6 months when the study commenced. ↓S, summer solstice; ↓W, winter solstice (Southern Hemisphere; latitude 40°S; natural daylength) (Semiadi *et al.*, 1995b).