A COMPARATIVE STUDY OF VOLUNTARY INTAKE AND RUMEN DIGESTION BY DEER, GOATS AND SHEEP

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DEDICATION

To my mother and father, to whom I am thankful for everything.

ABSTRACT

The following experiments were carried out to study the voluntary feed intake and rumen digestion of Red Deer and Angora-NZ feral goats, compared to Border-Leicester/Romney cross sheep, namely: (1) Intake and utilisation of a low quality threshed prairie grass straw (13.7 g N/Kg DM) by goats and sheep; (2) chewing behaviour per 24 h during eating and ruminating by goats and sheep fed on lucerne hay, and the efficiencies of chewing during eating and ruminating upon the breakdown of feed particles; (3) seasonality in nutrient supply by deer, goats and sheep fed on a medium quality lucerne hay diet (28.3 g N/Kg DM) in summer and in winter, and (4) the role of melatonin (Me) in the control of seasonal VFI in Red Deer.

1. Goats showed a superior utilisation of the low quality forage diet, with a greater voluntary intake (g/Kg $W^{0.75}$/d) of DM (55.6 g vs 33.8 g) and DDMI (17.4 g vs 8.2 g), apparent digestibilities of DM (31.2% vs 24.3%) and total fibre (36.8% vs 32.6%), especially that of lignin (11.3% vs 5.3%), when compared to sheep. The greater VFI (g/Kg $W^{0.75}$/d) by goats was associated with a larger rumen pool size (g/Kg $W^{0.75}$ of (DM + liquid) by goats than sheep (334.7 g vs 213.5 g). The superior fibre digestibility by goats was associated with a greater rumen NH_3-N concentration (mg N/L: 115 mg vs 80 mg), greater production rates of NH_3-N in the rumen (IRL: g N/Kg $W^{0.75}$/d of 0.84 for goats and 0.49 for sheep). A mechanism for increasing rumen NH_3-N concentration in goats was apparent through slower rates of inflow and outflow of water from the rumen (g/g DMI/d). Goats also showed greater rumen molar proportions of valerate and butyrate, and a tendency for a longer rumen MRT (h) of particulate DM (lignin and Ru-Phen), compared to sheep. Goats had smaller proportions (5.1% vs 9.6%) of large particles (>4.0 mm), and greater proportions (19.4% vs 16.1%) of small particles (<1.0 mm) in the rumen contents than sheep. The factors listed above would all favour the potential growth and attachment to feed particles of fibre-digesting bacteria in the rumen of goats, compared to sheep.

2. Goats spent more time chewing during eating (+3.1 h/24 h) and less time chewing during ruminating (-2.2 h/24 h) than sheep when fed on lucerne hay. Goats had a greater number of chews/min spent eating (154 vs 128) than sheep, and a smaller number of chews during ruminating (79 vs 100) than sheep. The efficiency of chewing during eating in breaking down feed particles to <1.0 mm (<C.EAT>) was greater by goats than by sheep (85% vs 48%) and <C.RUM> was smaller by goats than sheep (48% vs 59%). When corrected for the number of chews spent chewing during eating and ruminating, the differences in <C.EAT> and <C.RUM> between goats and sheep disappeared (for <C.EAT>, 2.1% vs 2.4%; for <C.RUM>, 0.6% vs 0.6%).

3. Sheep showed no evidence of seasonal cycles of VFI when fed on lucerne hay. In contrast to sheep, deer showed marked seasonal cycles of an increase in summer of voluntary DMI (+33.8%), DDMI (+29.9%), MEI (+25%), apparent fibre digestibility (+11.2%), MRT of lignin (+26%), rumen pool of DM + liquid (51.3%), internal recycling of water to the rumen (+74.1%), rumen NH_3-N concentration (+56.4%) and Ac/Pr ratio (+16%). All the cycles showed a trough in winter and a marked increase in summer. The expansion in the rumen pool size, a longer rumen MRT of digesta and a greater recycling of water into the rumen, allowed for an increase in VFI (without depressing apparent DMD), and for an increase in apparent fibre digestibility in summer.

Goats also showed an increase in voluntary DMI in summer (+19.7%), associated with increases in a number of rumen digestive functions, which were all not as marked as for deer. Unlike deer, the increased VFI in summer occurred at the expense of a reduced apparent DMD (-9.8%) and fibre digestibility (-5.8%).

Deer showed a faster rumen FOR of liquid (15.6%/h) than goats (10.0%/h) and sheep (10.4%/h) both in summer and in winter. Goats digested lignin, the least digestible component of fibre, more efficiently than sheep, both in summer (18.9% vs 14.6%) and in winter (21.9% vs 9.4%). The greater fibre digestibility by goats than sheep in winter was associated with a greater rate of NH_3-N production in the rumen (IRL of 1.13 g vs 0.98 g (g N/Kg $W^{0.75}$/d)). The threshold to passage of particles through the reticulo-omasal orifice was 1.0 mm

for deer, goats and sheep, with more than 98% of the particles in the faeces being <1.0 mm.

4. Exogenous subcutaneous implants of melatonin (Me) in spring in castrated male Red Deer caused reductions in VFI, water-filled rumen capacity, rumen digesta load, and heart rate (beats/min), to occur in both early and in late summer. Melatonin possibly entrains the seasonal cycles of VFI in Red Deer to photoperiod, and controls the seasonality of VFI. Methods are suggested for reducing the magnitude of the winter depression in VFI in Red Deer stags, using immunisation against Me.

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ABBREVIATIONS USED IN THIS THESIS

Cr-EDTA	Chromium complex of ethylenediamine tetraacetic acid
DDMI	Digestible dry matter intake
DM	Dry matter
DMD	Apparent dry matter digestibility
DMI	Dry matter intake
DOMI	Digestible organic matter intake
FDPR	Fractional disappearance rate
FDR	Fractional degradation rate
FOR	Fractional outflow rate
GH	Growth hormone
HCl	Hydrochloric acid
H_2SO_4	Sulphuric acid
ID	Internal diameter
IGF-I	Insulin-like growth factor I
IM	Intramuscular
IRL	Irreversible loss rate
IU	International units
K_2SO_4	Potassium sulphate
LH	Luteinising hormone
LHRH	Luteinising hormone releasing hormone
LWT	Liveweight
M	Metabolisable energy for maintenance
MCF	Malignant catarrhal fever
ME	Metabolisable energy
Me	Melatonin
MRT	Mean retention time
N	Nitrogen
^{15}N	Stable isotope of nitrogen
NaOH	Sodium hydroxide
NH_4Cl	Ammonium chloride
NH_3-N	Ammonia
$(NH_4)_2SO_4$	Ammonium sulphate
OD	Outer diameter
OM	Organic matter
OMD	Apparent organic matter digestibility
OMI	Organic matter intake
P	Prolactin

ABBREVIATIONS (continued)

RF	Rumen fluid
Ru-Phen	Ruthenium tris (1,10-phenanthroline)-ruthenium (II) chloride
s.c.	Subcutaneous
T	Testosterone
TH	Thyroid hormone
VFA	Volatile fatty acid
VFI	Voluntary feed intake
v/v	volume by volume
$W^{0.75}$	Metabolic liveweight