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DETERMINATION OF DIGESTION PARAMETERS TO DEVELOP AND EVALUATE FORAGE MIXTURES FOR PASTURE-FED RUMINANTS

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ABSTRACT

Animal production can be improved by lessening the dependence on ryegrass-based pastures as the sole source of nutrients for production. Ryegrass varies in quality and availability and supplementation with appropriate forages will maintain or improve production. This thesis defines the nutritive characteristics of a range of forages, including temperate and tropical grasses, legumes with and without condensed tannins, herbs and silages, in terms of chemical composition, products of degradation and rates of digestion using *in sacco* and *in vitro* methods. The forages assessed varied in crude protein concentration (CP; 7.6 – 29.9 % of dry matter; DM) and neutral detergent fibre (NDF; 22.4 – 57.8% DM), with commensurate net appearance of plant N as ammonia (0 to 49%) and *in sacco* DM, CP and NDF degradation rates (%/h) from 3 – 26, 3 – 19 and 4 – 28, respectively. The Cornell Net Carbohydrate Protein System (CNCPS) was used to evaluate the ability of forages to meet the energy and protein requirements of dairy cows. Data suggested sulla (*Hedysarum coronarium*), lucerne (*Medicago sativa*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens*) as potential forages for feeding with medium to low quality pasture.

Lambs were fed pasture, white clover, lucerne and sulla alone or in mixtures and production, rumen digestion parameters and estimates of protein synthesis were measured. Lambs fed white clover, sulla, lucerne:sulla and white clover:sulla had the highest daily intakes (1.47 – 1.54 kg DM) and liveweight gains (281 – 308 g) compared to lambs fed pasture (1.10 kg DM; 116 g). Sulla had potential for feeding with pasture and lucerne, but energy limited production. Protein synthesis between lambs fed lucerne, sulla and lucerne:sulla were similar (162 – 180 g/day) and greater than pasture (93 g/day). In a trial with dairy cows fed pasture (P), supplementation with maize silage (M) or sulla (S) did affect *in sacco* degradation and the maize silage lowered *in sacco* DM degradation rates (P, 7; M, 4; S, 16; P:M; 5; P:S, 11 and P:M:S, 6 %/h).

The work presented provides a foundation for formulating mixed forage rations to meet cow nutrient requirements and improve productivity in ryegrass-based pasture systems. Animal trials demonstrated synergistic effects of dietary components on both animal production and rumen microbial function.

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Yippee..........I've finished!!

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LIST OF ABBREVIATIONS

#	number
β	beta
μ	micro
μmol	micromole
^{35}S	labelled sulphur
^{3}H	labelled hydrogen
A	soluble fraction
A:P	acetate:propionate ratio
(A+B):P	acetate + butyrate:propionate ratio
AA	amino acids
ADF	acid detergent fibre
ADL	acid detergent lignin
B	degradable insoluble fraction
Bq	becquerel
c.	about
CP	crude protein
CT	condensed tannin
CV	coefficient of variation
CW	carcass weight
DM	dry matter
dpm	disintegrations per minute
ED	effective degradability
EDTA	ethylene diamine tetra acetic acid
EMA	eye muscle area
FDG	freeze-dried and ground
FSR	fractional synthesis rate
FV	feeding value
g	gram
x *g*	gravitational field
GR	fat depth 11 cm from the mid line of the 11^{th} and 12^{th} ribs
GT	grazing time
h	hour

I	intake
i.u	international units
i.d	internal diameter
IB	herbage intake per bite
ILR	irreversible loss rate
k	fractional disappearance rate per hour
kBq	kilobecquerel (10^3)
kg	kilogram
kJ	kilojoule
L	litre
LS means	least-square means
LW	liveweight
M	maize silage
MBq	megabecquerel (10^6)
ME	metabolisable energy
mg	milligram
min(s)	minute(s)
MJ	megajoule
mL	millilitre
mm	millimetre
mmol	millimole
N	nitrogen
n	number
NAN	non ammonia nitrogen
NDF	neutral detergent fibre
NH_3	ammonia
NH_3-N	ammonia nitrogen
NIRS	Near InfraRed Spectroscopy
nmol	nanomole
NV	nutritive value
o.d	outside diameter
°C	degree celcius
OM	organic matter
OMD	organic matter digestibility
P	pasture

PD	potential degradability
P:M	pasture:maize silage
P:M:S	pasture:maize silage:sulla
P:S	pasture:sulla
Pr	probability
r	correlation coefficient
RB	rate of biting
REML	residual maximum likelihood
RFC	rapidly fermentable carbohydrates
S	sulla
SC	soluble carbohydrate
SD	standard deviation
SDS	sodium dodecyl sulphate
SEM	standard error of the means
SO_4	sulphate
Sp(p)	species
SRA	specific radioactivity
SS	sulla silage
t DM/ha/yr	tonnes dry matter per hectare per year
t	incubation time
TBq	Terabecquerel (10^{12})
TMR	total mixed ration
TQ	transfer quotient
UDP	undegraded protein
US	United States
VFA	volatile fatty acids
VFI	voluntary feed intake
vs.	versus
w/v	weight to volume
WBPS	whole body protein synthesis
WC	white clover
x M	maintenance feeding

LIST OF PUBLICATIONS

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