THE EFFECTS OF LEAF SHEAR BREAKING LOAD ON THE FEEDING VALUE OF PERENNIAL RYEGRASS FOR SHEEP

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Preface

The contents of this thesis represent original work conducted by the author under the supervision of Dr Ian Brookes and Professor Tom Barry of Department of Animal Science, Massey University and Dr Andrew John of Applied Biotechnology Division, DSIR and Dr Warren Hunt of Grasslands Division, DSIR.

Abstract

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Reducing physical resistance has been thought to be a key factor to increase efficiency of masticatory breakdown of forage, which may lead to faster rumen fractional outflow rates (FOR) and consequently to increased voluntary feed intake and hence improved feeding value (FV). Two selections of perennial ryegrass (PRG) were selected for low (LS) and high leaf shear breaking load (HS) based on the maximum load required to shear across the leaf, i.e. leaf shear breaking load (LSBL). The series of experiments were conducted to investigate the effects of LSBL on the FV of PRG for sheep.

LSBL, morphological and anatomical parameters were measured on the LS and HS PRG selections grown under the optimum climatic conditions. LSBL for the LS PRG selection was approximately 41 % lower the HS PRG selection. However, the LS selection had shorter leaf lengths, narrower leaf widths and narrower leaf cross-sectional area (CSA) than the HS selection. Therefore, in leaf shear strength (LSS), the LS selection was estimated to be approximately 27 % less resistant to shear than the HS selection per unit of CSA. The lower LSS in the LS selection is due to the lower concentration of sclerenchyma tissues in leaf CSA compared with the HS selection. However, the differences in the total shear load required to breakdown a unit dry weight of leaves to 1 x 1 mm particle size, namely, leaf index of masticatory load (IML) between the selections were influenced by the differences in morphological characteristics of leaves between the two PRG selections.

Comparisons were made between the LS and HS PRG selections in the efficiency of mastication by sheep on particle breakdown. There were no major effects of reduced LSBL in PRG on the efficiency of mastication during eating and during

rumination. Although the LS PRG selection was approximately 29 % lower in LSBL than the HS PRG selection, the difference for the two PRG selections in IML was almost nil.

Effects of LSBL in PRG on rumen fractional outflow rate (FOR) and apparent digestibilities were investigated in sheep fed at restricted feed intake levels. There were no effects of reduced LSBL on FOR, although the LS PRG selection was approximately 39 and 12 % lower than the HS PRG selection in LSBL and IML, respectively. The digestibility of the cellulose fractions was approximately 16 % lower in the LS PRG selection than the HS PRG selection. The leaf morphology in PRG may affect the efficiency of fibre digestibility.

Two field trials were conducted to test the hypothesis that LSBL in PRG improves FOR and leads to higher voluntary feed intake, and hence achieves improved live weight gain and wool production, namely FV. Although the LS PRG selection had 25-30 % lower LSBL than the HS PRG selection, live weight gain and wool production of sheep were not improved by reduced LSBL. FOR in sheep showed no indications of difference and voluntary feed intake was similar between the animals grazing the LS and HS PRG selections. The lack of difference in IML between the LS and HS PRG selection can be considered as a main reason for this. The hypothesis, that reduced LSBL in PRG would improve its FV, was therefore rejected.

In conclusion, there were no major effects of reduced LSBL in PRG on efficiency of masticatory particle breakdown, and consequently, FOR, feed intake and hence FV in sheep. This is due to the lack of selection effect of PRG in IML. IML is a determining factor for the efficiency of mastication both during eating and rumination. The selection of PRG for a lower IML will, therefore, be necessary in order to increase efficiency of masticatory particle breakdown, FOR and hence FV of PRG.

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List of Abbreviations

General

ADF	acid detergent fibre
CAC	controlled atmosphere cabinet
<C.EAT>	efficiency of chewing during eating in reducing particles to < 1.0 mm
Co	cobalt
Co(III)-EDTA	cobalt ethylenediaminetetraacetic acid
Cr	chromium
<C.RUM>	efficiency of chewing during rumination in reducing particles to < 1.0 mm
Cr_2O_3	chromium sesquioxide
Cr-EDTA	chromium ethylenediaminetetraacetic acid
CSA	cross-sectional area
d	day
DM	dry matter
DOMI	voluntary intake of digestible organic matter
DSIR	Department of Scientific and Industrial Research
ep	epidermis
EPM	Ellinbank pasture meter
Fig.	figure
FOR	fractional outflow rate
FV	feeding value
GLM	general linear model
HS	high leaf shear breaking load
IML	index of masticatory load
IVDMD	in vitro dry matter digestibility
IVOMD	*in vitro* organic matter digestibility
L.	*Linnaeus*

LS	low leaf shear breaking load
LSBL	leaf shear breaking load
LSS	leaf shear strength
LWG	live weight gain
LWR	leaf length:dry weight ratio
M.	*Musculi*
M00	maturation
M10	10 days after full maturation
M20	20 days after full maturation
ms	mesophyll
N	nitrogen
na	not available
NDF	neutral detergent fibre
NH_3-N	ammonia
NV	nutritive value
OM	organic matter
OE	oesophageal extrusa
PRG	perennial ryegrass
RTOM	apparent retention time of organic matter in the rumen
Ru	ruthenium
Ru-Phen	ruthenium tris (1,10-phenanthroline) ruthenium (II) chloride
sc	sclerenchyma
<TEC>	theoretical efficiency of chewing
TSL	total shear load
VFA	volatile fatty acid
VOMI	voluntary organic matter intake
vs	vascular bundle
v/v	volume by volume
WB	Warner-Bratzler
WC	white clover

Units

a	are
c	centi-
C°	degree centigrade
g	gram
G	Newtonian constant of gravitation
h	hecto-
hr	hour
in	inch
J	joule
k	kilo-
l	litre
m	milli-
m	metre
M	mega-
M	mole
μ	micro-
min.	minute
%	per cent
W	watt

Statistical

df	degrees of freedom
n	number of observations
r	correlation
RSE	root square of error
s.e.	standard error
S.E.D.	standard error of difference
ns	not significant
*	significant at $p<0.05$

**	significant at $p<0.01$
***	significant at $p<0.001$
I	indicating ranges of standard error in figures