DIFFERENCES BETWEEN MERINO SELECTION LINES IN MICROBIAL YIELD FROM THE RUMEN AND UTILISATION OF PROTEIN FOR WOOL GROWTH.

by

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January 1996

A thesis submitted for the degree of Doctor of Philosophy of the University of New England.

Certificate

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

L.P.Kahn

Acknowledgements

This work was conducted whilst the author was in receipt of a scholarship from the International Wool Secretariat. Funding of the research was made available by Australian woolgrowers through the International Wool Secretariat.

I wish to thank my supervisors, Professors R.A.Leng and L.R.Piper for their help and supervision during the period of my candidature. I also thank Associate Professor J.V.Nolan and Dr. S.Bird for valuable discussions during the course of my research and for help during the preparation of this thesis. The comments of Professor. J.Rowe on Chapter 10 are also gratefully acknowledged.

I extend my thanks to all those who provided technical assistance, and in particular, Mr. F.Ball, Mr. S.Stachiw, Mr. R.Woodgate, Mr. M.Porter, Mr. D.Olde, Mr. P.Littlefield and Mr. M.Crestani. The assistance provided by members of the Meat Quality group, including Mr. A.Ball and Mr. M.Weber, for the computer aided tomography reported in Chapter 10 is also acknowledged. I also thank my wife, Carol, for interpreting and measuring the cat-scans that were reported in the studies described in Chapter 10

I thank the members of the Sheep Breeding Program, C.S.I.R.O, Chiswick and in particular, Dr. A.Swan, for allowing use of the Sirolan-Laserscan and the Merino bloodlines and experimental design used in Chapters 12 and 13. The experiments conducted with these animals were performed at the C.S.I.R.O. property, Longford, and I thank the field staff at Longford, Mr. N.Gibson, Mr. K.Archer and Mr. B.Towells, for their assistance during these experiments.

I thank my friends, Janet and Douglas Beckers, for proofreading the final version of this thesis. I am also very thankful to Carol for keeping me aware that work is only a part of one's life. Thankyou.

Table of Contents

Literature Review

Experimental Section

List of Figures

List of Tables

Summary

Introduction

With most diets, microbial cells are the major contributor to total non-ammonia nitrogen flowing to the intestines, and the latter is the primary determinant of wool growth rate. Consequently, at constant intake, variation in the yield of microbial cells, more specifically microbial protein, from the rumen may account for a proportion of the between-sheep variation in wool growth rate. Recently, urinary excretion of purine derivatives has been suggested as a non-invasive method for estimating the yield of microbial protein from the rumen. However, some doubts exist as to the validity of this technique. Thus the studies reported in Chapters 8 and 9 examined the metabolism of allantoin, the major purine derivative in the urine of sheep, in an attempt to determine if the urinary excretion of purine derivatives is a valid method for estimating the yield of microbial protein from the rumen.

In the studies reported in Chapters 10 and 11, the urinary excretion of purine derivatives was used to examine whether divergent selection for clean fleece weight had produced animals that differed in the yield of microbial protein from the rumen. In addition, the importance of yield of microbial nitrogen from the rumen and the efficiency of utilisation of absorbed amino acids, in accounting for differences between the selection lines in wool growth rate was calculated.

Finally, the suitability of lithium chloride as a marker of supplement intake in grazing sheep was assessed in the studies reported in Chapter 12. The studies reported in Chapter 13 used lithium chloride as a marker of supplement intake to determine whether genetic variation existed between fine-wool Merino bloodlines, grazing at pasture, in the response of wool growth rate, average fibre diameter and live weight gain to increasing amino acid intake.

Abstracts

Chapter 8

Allantoin metabolism was studied in two rumen-cannulated sheep by means of a single intravenous injection of [4,5-^{14}C] allantoin. The decline in the specific radioactivity of allantoin in plasma was best described by a double exponential function, indicating that in sheep, allantoin moves between at least 2 kinetically distinct compartments. Recovery of ^{14}C-allantoin in urine for the 12 h following tracer injection was about 80% of the ^{14}C-allantoin

injected. Only negligible amounts of radioactivity entered saliva indicating that the transfer of allantoin to the rumen via saliva was quantitatively unimportant. In support of this, the mass of allantoin-C that was degraded and appeared in either blood or rumen HCO_3^- was on average less than 5% of the net flux of allantoin through the blood pool. This indicates that ruminal, post ruminal and tissue associated degradation of allantoin to carbon dioxide in the sheep is quantitatively unimportant. In light of this, use of allantoin excretion in urine to estimate the flow of microbial protein in rumen digesta will not have to be corrected for transfer to the gut and subsequent degradation.

Chapter 9

The sensitivity of estimates of allantoin net flux to changes in allantoin supply was determined on two rumen-cannulated sheep which were equipped with bladder catheters and received a continuous intra-jugular infusion of [4,5-^{14}C] allantoin for 17 h. Unlabelled allantoin (tracee) was included in the infusate for the final 7 h of the infusion. Estimates of allantoin net flux derived from plasma and urine differed but these differences were largely removed during infusion of the tracee. Transfer of allantoin-C to bicarbonate in blood or rumen fluid was negligible and this was in agreement with the previous study reported in Chapter 8. The recovery of tracee which was taken to be the difference between the estimates of net flux prior to and after infusion of tracee was on average 55% and 83% for estimates made in blood plasma and urine respectively. This disparity is of concern, and suggests that the use of allantoin flux rates in blood to predict microbial yield from the rumen should be used with caution.

Chapter 10

The physiological consequences of divergent selection for (fleece plus; F_p) or against (fleece minus; F_m) clean fleece weight were measured in 6 year old Merino ewes from the Trangie fleece selection lines when fed a roughage diet supplemented with differing levels of urea. Ewes from the F_p flock had a 15% greater voluntary intake (adjusted for metabolic weight) but there were no differences between the selection lines in the apparent digestibility of DM in the whole-tract. There were no differences between the selection lines in the concentrations of rumen ammonia or total volatile fatty acids, the ratio of propionate:(acetate + butyrate) or pH in rumen fluid taken 4 h after feeding. Urinary excretion of purine derivatives and the amount of purines excreted per unit dry matter intake (DMI) was greater in ewes from the F_p flock.

This suggests that the yield of microbial nitrogen from the rumen and the yield of microbial nitrogen per unit DMI was greater in these ewes.

The body composition of a representative sample of ewes from both flocks was estimated at the start and conclusion of the trial (117 d) by computer aided tomography. Ewes in the F_p group had a proportionally leaner body and also a greater mass of viscera (F_p 6.5, F_m 5.1 kg). In F_m ewes fat represented over 30% of the wool and digesta-free body mass compared to less than 20% for ewes from the F_p flock.

Chapter 11

Voluntary feed intake, apparent digestibility of DM in the whole-tract (ADMD), urinary excretion of purine derivatives and nitrogen retention were measured in 6 year old Merino ewes from the Trangie fleece plus (F_p) and minus (F_m) selection lines when fed, either once per day or hourly, an oaten chaff diet with 1% urea. When fed once per day, ewes from the F_p flock consumed 20% more feed by 4 h after feeding but differences between the selection lines for all other variables were not statistically significant. When the feeding regime was changed to hourly, ewes from the F_m flock had a greater ADMD but the yield of microbial nitrogen (as estimated from urinary purine excretion) per unit dry matter and nitrogen intake was greater in ewes from the F_p flock.

When the data from the two feeding regimes were combined, a significant selection line x feeding regime interaction was recorded for ADMD and digestible dry matter intake. Ewes from the F_p flock tended to have a greater yield of microbial nitrogen from the rumen but the selection line differences were not statistically significant.

Chapter 12

The suitability of lithium chloride as a marker for supplement intake was examined in grazing sheep. Eight merino weaners (8 months of age), grazing improved pasture, were individually fed cottonseed meal pellets sprayed with lithium chloride and plasma lithium concentrations were then measured over the next 29 h. The results of this study showed that after ingestion of lithium, plasma lithium concentrations rose to reach a maximum 4 h later. The concentration of lithium in plasma remained substantially constant between 4 and 14 h after lithium ingestion and thereafter declined slowly. The use of plasma lithium concentration (scaled for live weight) 4–9 h after lithium ingestion facilitated accurate prediction of supplement intake.

In a following experiment, 732 merino weaners (8 months of age) were split into two groups by randomised stratificatio . These groups were fed a cottonseed meal supplement at either 55 or 110 g/hd/d. In orde:r to estimate individual supplement intake over a 62 day period, the supplement was spra:/ed with lithium chloride on three occasions at monthly intervals. The results of the three estimates of intake showed that within mobs (n = 366/mob) large variation in supplement intak existed.

Both the heritability (0.17) and repeatability (0.48) of supplement intake as estimated from paternal half-sib analysis were significantly different from zero.

Chapter 13

Greasy wool growth, average fibre diameter and live weight and the response of these traits to increasing amino acid intake were neasured in a group of 1100 Merino weaners (8 months of age) comprising 9 fine-wool and 2 nedium-wool bloodlines. Amino acid intake was increased by supplementation with a cottonseed meal pellet. Wool growth, average fibre diameter and live weight gain (fleece-free) increased linearly with estimated pellet intake. A significant bloodline x pellet intake interacti on occurred for both wool growth and live weight gain (fleece-free). These interactions suggest that the bloodlines differed in the efficiency with which cottonseed meal was metabolised to either wool or tissue.