
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

Nutritional effects on fibre growth cycles and medullated fibre production in Angora goats

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ABSTRACT

The effect of nutrition on fibre growth cycles and medullation in skin of Angora goats was investigated by microscopy of transverse sections of hair follicles. Samples of skin and fleece were taken at regular intervals between August 1989 and August 1990 from non reproducing does fed either maintenance (MPA) or ad libitum (HPA) pasture allowances. There were no differences in follicle activity between nutritional treatment groups for any of the 11 sample dates. Primary follicles grew and shed their fibres seasonally, with the main growth period from September to May and the mean nadir of 26± 6% in August. Mean secondary follicle activity did not fall below 95% in HPA goats, or below 85% in MPA goats, however, there was large between animal variation. Primary central follicles grew kemp fibres. Primary lateral follicles produced both kemp and gare fibres. Secondary follicles grew mostly unmedullated mohair, but gare fibres were grown by some earlier developing secondary follicles. Goats on higher feed intake had greater degree of medullation in fibres of lateral primary follicles in October and February, and in secondary follicles in February, March and May. These data suggest that nutritional effects on kemp content of the fleece are achieved through a shift in fibre type within all follicle types.

Keywords Angora goat, hair follicle, kemp, mohair, nutrition, seasonality, shedding.

INTRODUCTION

Kemp fibres are course, strongly medullated fibres, which grow and shed seasonally from primary hair follicles (Stapleton, 1978). Although they generally constitute less than five percent of the fleece, kemp fibres are considered highly undesirable in mohair processing and have a large influence on price (Sinclair, 1988). An association between nutritional status and levels of the kemp fibre type in Angora fleeces was shown when Angora bucks fed supplementary concentrates during the 1987 Central Performance Tests at Whatawhata had higher kemp levels than bucks fed pasture alone. In a subsequent trial using non-reproducing does, Bown *et al.* (1990) found does on high pasture allowance during spring produced fleeces with 1.6% higher kemp content than does on low pasture allowance.

A trial was conducted to examine the effect of nutrition on medullation over the full year, and to define the relationship between follicle type, follicle activity cycles, and degree of medullation in response to pasture allowance. This preliminary report provides a description of seasonal patterns of follicular activity, and elucidates the mechanism by which feed intake affects the kemp content of the mohair fleece.

MATERIALS AND METHODS

From 3 August 1989, 104 mixed-age Angora does were strip-grazed in two mobs on ryegrass/clover pasture. One mob, on maintenance pasture allowance (MPA), received approximately 1.0 kg DM/head/day so as to maintain adult liveweight over the period of the experiment. The other mob, on high pasture allowance (HPA) was grazed *ad libitum.*

The animals were randomly allocated to eight groups, balanced for liveweight, kemp, and fibre diameter. Two of the eight groups were grazed on continuous MPA or HPA, while the remaining six were crossed over between nutritional treatments on 19 October 1989 and/or 13 February 1990. All animals were shorn and their fleeces weighed in August and February. Fibre samples were clipped from the mid side region of all 104 animals in August and October 1989, and February, May and August 1990. These were

TABLE 1 Fleece characteristics of Angora does grazed at high-(HPA) and maintenance (MPA) pasture allowances.

Sample date	Trtmt	Fibre diameter (%) mean	sed	Gare (%) mean	sed	Kemp (%) mean	sed	Fleece weight (kg) mean	sed
Aug-89	HPA	31.0	-	2.94	-	3.67	-	-	-
	MPA	30.9		1.91		4.09		-	
Oct-89	HPA	30.6	0.80 NS	1.41	0.122 NS	7.71	0.727 **	-	-
	MPA	29.5		1.32		5.76		-	
Feb-90	HPA	33.0	0.45 NS	0.96	0.131 NS	5.36	0.482 **	1.77	0.074 NS
	MPA	32.6		1.01		4.08		1.66	
May-90	HPA	34.6	0.42 *	1.38	0.142 NS	5.18	0.484 NS	-	-
	MPA	33.5		1.58		6.59		-	
Aug-90	HPA	34.8	0.47 ***	1.47	0.142 NS	3.66	0.466 NS	1.45	0.056 ***
	MPA	32.6		1.47		2.89		1.25	

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

analysed by the Whatawhata Fibre Test Centre for fibre diameter, medullation (gare), and kemp.

Skin samples were taken from the two groups of non-reproducing does, each comprising 9 animals, which received continuous MPA or HPA treatments. Mid-side snip biopsies were excised at intervals ranging from 20 to 42 days, so as to coincide with crossover dates. Skin samples were fixed in Bouin's fluid, processed to wax, serial sectioned parallel to the skin surface at 7 µm thickness, and stained according to a modified sacpic method (Auber, 1952). Approximately 200 hair follicles per sample were examined in transverse section at sebaceous gland level, and classed according to follicle type (primary central, primary lateral, or secondary), activity state (active or quiescent), and degree of fibre medullation (kemp, gare, or mohair). The criterion for distinguishing kemp from other medullated (gare) fibre in both fibre and follicle assessments was a medulla comprising greater than 60% of fibre diameter. In this report, the terms "medullation" and "medullated" describe all fibres possessing a medulla, including kemp. The term "gare" refers to fibres with narrow medullae or "intermediate" fibres (as in Stapleton, 1978).

Monthly follicle activity and medullation of MPA and HPA treatments were compared using regression analysis of angular transformed data with age as a covariate. Fleece parameters were subjected to a similar analysis with age and crossover treatment as covariates.

RESULTS

The results of regression analyses comparing fleece characteristics of goats on MPA and HPA treatments, with means and SEDs adjusted for age and crossover effects, are shown in Table 1. There was no effect of pasture allowance on fibre diameter up to the February shearing, but fleece samples from HPA goats were coarser in May and August 1990 samples. Grazing treatment had no effect on fleece medullation (gare). Kemp content of fleece samples was greater in goats receiving HPA than those on MPA up to shearing in February, but no significant difference in kemp was observed between February and August 1990.

Primary follicle activity (Fig. 1) showed a marked seasonal pattern, with activity increasing in spring and declining in winter. At no sample date did primary follicle activity of MPA and HPA treated goats differ. Mean secondary follicle activity (Fig. 2) remained at high levels throughout the year, with values from MPA goats only dropping below 90% in August 1989 (89%) and May 1990 (85%). No differences between grazing treatments were significant when compared using regression analysis (P>0.10), however it is noteworthy that the MPA group was generally more variable, with August values ranging from 52% to 99% activity.

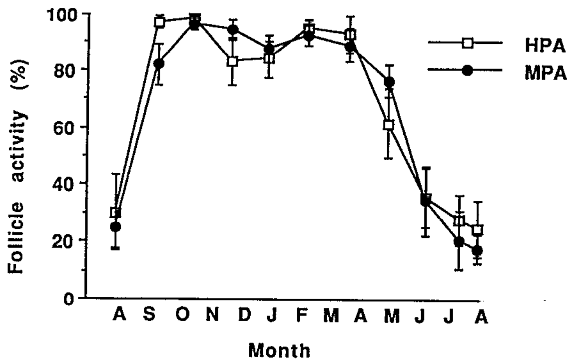

FIG 1 Primary follicle activity at the mid side of Angora does grazed at high-(HPA) and maintenance (MPA) pasture allowances.

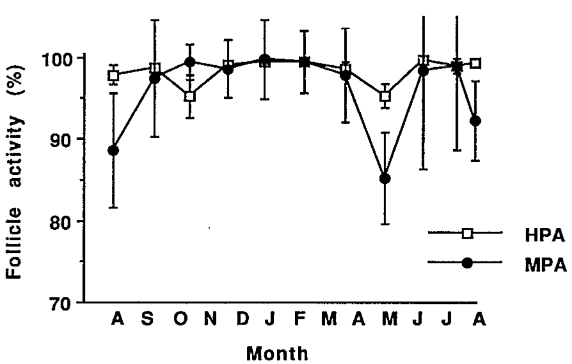

FIG 2 Secondary follicle activity at the mid side of Angora does grazed at high-(HPA) and maintenance (MPA) pasture allowances.

Active primary central follicles of goats on both grazing treatments mostly contained kemp fibres. The pattern of kemp growth in this follicle type thus followed the pattern of primary follicle activity (Fig. 1). No kemp was observed growing in goats of either nutritional treatment in August 1989, but the mean percent kemp in primary central follicles reached peaks in October (92%) and March (86%), then dropped to low levels between June and August 1990 (less than 7%). Kemp was also produced by some primary lateral follicles (Fig. 3) with HPA goats attaining higher levels than MPA goats in October and February (P<0.05). However, the overall production of medullated fibres (kemp + gare) differed only in the month of September (P<0.05). There was a biannual pattern of fibre growth in both primary central and primary lateral follicles, with kemp and gare fibre growth maxima in spring and autumn (Fig. 1 and 3). Fibres with very narrow medullae were also grown by a small proportion of secondary follicles (Fig. 4). Medullation in this follicle type was higher in HPA than in MPA treated goats in the successive samples taken in February, March and May (P<0.05).

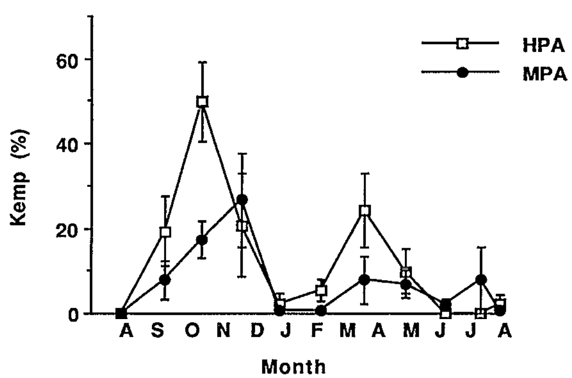

FIG 3 Kemp fibres in primary lateral follicles of Angora does grazed at high-(HPA) and maintenance (MPA) pasture allowances.

The mean ± SEM for S/P ratio of all goats over all samples of the trial was 7.88±0.13. S/P ratio did not differ at any sample date between HPA and MPA treated goats (P>0.10). From September 1989 until August 1990 the liveweight of HPA goats was approximately 1.8 kg greater than that of MPA goats.

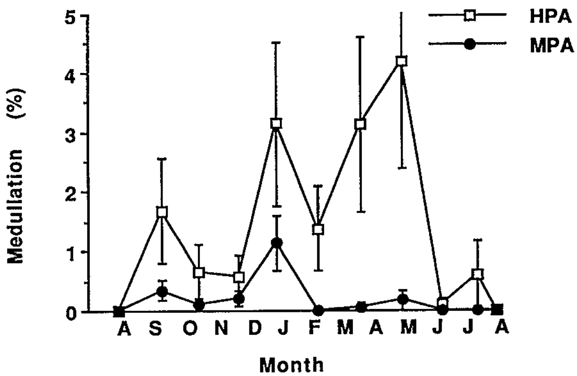

FIG 4 Gare fibres in secondary follicles of Angora does grazed at high- (HPA) and maintenance (MPA) pasture allowances.

DISCUSSION

The results of this study support the findings of Bown *et al.* (1990) that feed intake can influence mohair fleece quality, particularly kemp levels. The observation of this nutritional effect is extended over a full year, and is accounted for by a shift in fibre type grown within each follicle type. Differences in fleece characteristics between nutritional treatment groups could not be attributed to duration or timing of hair cycles. Differences in fleece kemp levels did, however, occur after the periods of maximal primary follicle activity (Fig. 1).

Whereas most, if not all, primary central follicles produced kemp fibres, the extent of medullation was more variable in fibres grown by primary lateral follicles. These follicles showed little significant change in total medullation, but increased kemp growth in response to higher feed intake. This suggests that some primary lateral follicles produced kemp, where, on lower nutritional conditions they would have produced gare. Angora goats have a tendency to develop extra primary lateral follicles (Wentzel and Dreyer, 1967), and these were evident in the material of this study as follicle groups comprising more than three primary follicles. The potential for nutritional effects on fleece characteristics via the primary lateral follicle type is therefore increased in relation to animals exhibiting the regular primary trio developmental pattern.

Secondary follicles also showed a change in medullation with nutritional level. Secondary follicles from goats receiving high pasture allowance contained significantly more medullated fibres than those on maintenance pasture allowance. No secondary follicles grew kemp, and all medullae of this follicle type were very narrow. They were also positioned on the secondary margin of the follicle group, suggesting that only the earlier developing secondary original follicle type grew medullated fibre. Therefore, the influence of nutrition on kemp content of the fleece is at least partly explained by a shift in the degree of medullation of fibres grown in all follicle types, most notably in primary lateral follicles.

This finding contrasts with data from cashmere goats. Following a study of a similar nutritional effect on fibre growth in this breed, McGregor (1988) concluded that under restricted feed intake, nutrients were preferentially diverted toward down growth from secondary follicles, resulting in increased yield and decreased diameter and hairiness. In Angora goats, however the relationship between follicle type and fibre type is not as fixed as in cashmere goats. The increased medullation in both primary and secondary follicles means that the higher feed intake Angora goats of the present study actually had more kemp producing follicles than those on maintenance intake. While this is sufficient to explain effects on the fleece, differential fibre growth rates resulting from a change in nutrient partitioning between follicle types can not be excluded on the basis of the present data.

This trial has provided information on seasonal variation in hair follicle activity of Angora goats. Primary follicles shed and grew new kemp fibres in spring, and mostly became inactive over winter, as reported by Margolena (1974) and Stapleton (1978). Dreyer and Marincowitz (1967) also observed spring shedding of primary follicles. The two peaks of fibre growth in spring and autumn support previous suggestions of biannual kemp growth (Stapleton, 1978; Winklmaier, 1983). It is not possible to determine from the present data what proportion of follicles undergo two cycles per year, however, this phenomenon has important implications for minimizing kemp length through time of shearing. By contrast, secondary follicle activity shows much less seasonal variation. In most animals, greater than 90% of secondary follicles grew mohair over much of the year. In some goats, notably those on maintenance treatment, secondary follicle activity dropped seasonally to as low as 52 %, although with the small number of animals sampled, no significant treatment effect could be found. Some secondary follicle shedding during spring has also been observed in other Angora flocks (Margolena, 1974; Stapleton, 1978). Fibre growth in New Zealand Angoras is therefore consistent with the limited accounts of Texan, South African and Australian animals.

ACKNOWLEDGEMENTS

J.B. Clayton and D.G. Fraser were responsible for animal and pasture management. B.J. Young assisted with microtomy. A. Kellick assisted with data management. Statistical analysis was conducted by B.W. Dow and D.M. Duganzich. The assistance of Dr M.L. Bigham is gratefully acknowledged.

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