

Medullation in mohair

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ABSTRACT

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Experiments reporting incidence of medullated fiber in mohair were reviewed. Genetics, nutrition, season and disease have been implicated in affecting medullation levels which are variable within fleeces. To measure medullation accurately, representative samples of the whole fleece must be measured. Subjective medullation scores are of limited value since they are not highly correlated with actual measurements of medullation. Progress towards reducing medullated fibers in mohair is possible by selection of animals older than one year of age. The environmental factors nutrition, geographical location and disease have minimal effects on medullated fiber production. Effects of season and management on medullation are not clear.

INTRODUCTION

Genetics and management of kemp in mohair were reviewed by Tiffany-Castiglioni (1986), but recent developments warrant a re-examination of this subject. Kemp is an extreme form of medullated fiber which is usually visible to the naked eye as a chalky white fiber in the natural and dyed states. Kemp fibers in mohair create problems in textile fabrics since they differ in appearance from unmedullated fibers. The undesirability of medullated fibers in mohair is well documented (Smuts, et al., 1983; Smuts and Hunter, 1987a,b). A medullated fiber is an animal fiber that in its original state includes a medulla (ASTM, 1989); the diameter of the medulla of a medullated (med) fiber is less than 60% of the diameter of the fiber; the diameter of the medulla of a kemp fiber is 60% or more of the diameter of the fiber. Further clarification is in Fig. 1. These definitions do not differentiate between medullated fibers on the basis of length.

Above about 100 μm in fiber diameter, all medullated fibers are kemp, between 20–30 μm , all medullated fibers are med, below 20 μm , there are no medullated fibers in mohair.

Tiffany-Castiglioni (1986) observed that kemp might be reduced by ge-

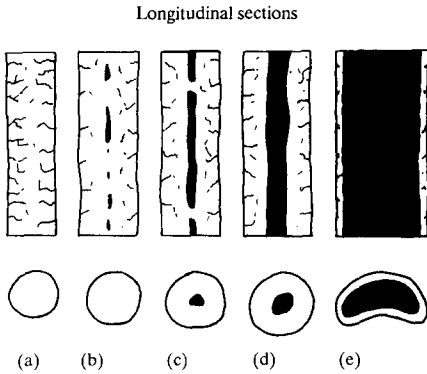


Fig. 1. Types of medulla in mohair fibers. (a) Non-medullated fiber (b) fragmented med fiber (c) interrupted med fiber (d) continuous med fiber (e) continuous kemp fiber.

netic selection, environmental modification or both. A genetic approach requires the trait be heritable, while an environmental approach requires that external factors (e.g., season, climate, level or type of nutrition) affect kemp production.

Several studies have been confounded to varying degrees by at least two factors: location on the Angora goat at which samples were taken; and secondly, subjective assessment of kemp. A study by Bassett (1986) revealed that kemp levels in samples taken from the rump, britch and adjacent to the tail were invariably higher (1.09–1.47%) than levels measured on the neck, shoulder and mid sides (0.25–0.65%). Compared to levels in the fleece as a whole, measurements taken on mid-side samples normally produce misleadingly low kemp levels. Further, kemp percentage in side samples is only moderately correlated ($r=0.37$, Lupton et al., 1986) with that measured in core samples of whole fleeces.

Medullation (or more commonly, kemp) scores are probably only useful for identifying animals containing high concentrations of visible kemp. It has been observed (Shelton, personal communication, 1989) that the current overall low level of kemp in Texas Angora goats is a result of selection based on visual assessment. Because of low correlations between subjective visual assessments of kemp and actual measurements ($r=0.20$, Lupton and Shelton, 1989a; $r=0.05$, Gifford et al., 1990), further reduction in kemp production will only be realized with the assistance of objective measurements (Tiffany-Castiglioni, 1986; Lupton and Shelton, 1989b) using samples representative of the whole fleece.

Heritability of medullated fibers

Tiffany-Castiglioni (1986) noted that the heritability of kemp has been reported in the range of 0.05–0.43. With no exceptions, reported heritability

estimates were based on visual kemp scores. Shelton and Bassett (1970) estimated the heritability of kemp score as 0.43. This was based on lifetime records of 510 animals using data from the second through fourteenth fleeces. However, 83% of the data were the result of assessing kemp on animals less than three years of age. Shelton and Snowden (1983) estimated heritability of kemp score in the range 0.05–0.19. Observations were made on the first, second and third fleeces produced by 312 offspring of 22 sires. More recently, Gifford et al. (1990) estimated heritabilities for mohair production traits using 572 half-sib records of one-year old does and intact males from 30 sires. Estimated heritability for percent medullated fibers was zero. Heritability for kemp score was 0.36. Phenotypic correlation between kemp score and percentage of medullated fibers was very low ($r=0.05$). The same authors also reported heritability values for these same traits from data of doe fleeces shorn between 13 and 73 months of age. The estimate of heritability for percentage of medullated fibers was 0.39. Heritability for kemp score was slightly higher (0.42), which was in close agreement with Shelton and Bassett (1970). Gifford et al. (1990) concluded that genetic progress towards reducing medullated fibers could be expected by direct selection of individual animals at ages greater than one year. This conclusion is supported by earlier studies of Shelton and coworkers (1970 and 1983).

Questions remain concerning the relationship between objective and subjective measures of medullated fibers since kemp scoring is subjective and difficult. Most kemp, but few med fibers, are visible to the discerning eye. Thus, previously reported low correlations (0.05, 0.20) between kemp score and percentage medullated fibers are expected. Lupton and Shelton (1989a) evaluated data from 306 intact males in the 1988 Texas Angora Goat Performance Test. Whole fleeces were sampled using a 1.27 cm diameter coring device. A minimum number of 32 cores was randomly removed from each fleece. The samples were washed and medullation (med and kemp content) of the scoured fibers was determined in accordance with ASTM Standard Test Method D2968 (ASTM, 1989). A phenotypic correlation of 0.33 was reported between percentage of med and percentage of kemp. This was the only significant correlation of percentage of kemp with any other production trait measured or assessed in this performance test, including lock type, animal weight, weight gain, mohair production or fineness (Lupton and Shelton, 1989b). Thus, selection for kemp reduction would be expected to have no effects on these production traits.

An additional question remains. Would selection against all medullated fibers result in a reduction of kemp? Alternatively, are med and kemp fibers simply degrees of the same characteristic? Blakeman et al. (1989) examined these questions. Figure 2 illustrates the relationship between medulla diameter and fiber diameter. The source of the 2659 medullated fibers shown in the graph is a broad cross section of U.S. mohair types. The line through the data

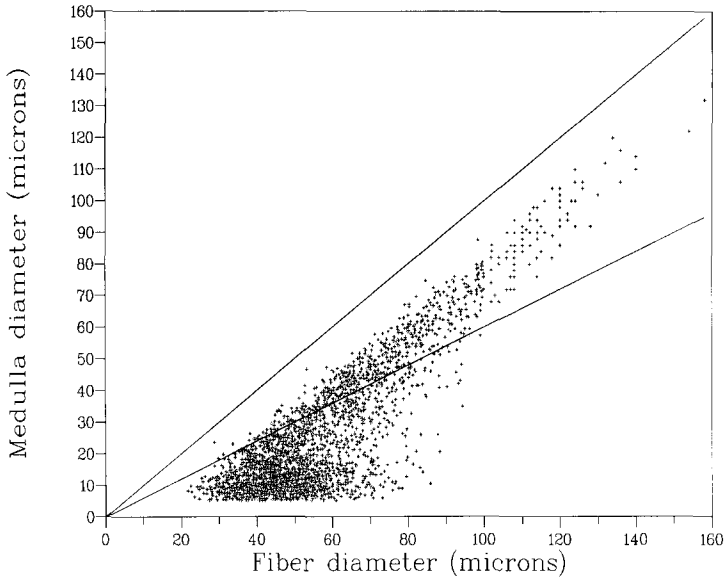


Fig. 2. Relationship between medulla diameter and fiber diameter for 2659 medullated Texas mohair fibers (pooled data).

points represents the theoretical division of med from kemp, as defined previously. The graph shows no obvious division between these two types of fibers, which prompts the tentative conclusion that med and kemp production may be a single trait. However, it is also quite possible that med and kemp production are separate traits resulting in fibers having overlapping medulla characteristics. The ratio of medulla diameter to fiber diameter is quite variable, though the general trend is for medulla diameter to increase with fiber diameter. Above approximately $100\ \mu\text{m}$, all medullated fibers are kemp. Between 20 and $30\ \mu\text{m}$, all medullated fibers are med. Below $20\ \mu\text{m}$, there are no medullated fibers. The degree of parallelism between the 45° line and the upper extreme data points suggests a limiting thickness (about $5\ \mu\text{m}$) of solid keratin surrounding the medulla. A similar observation for the lower extreme data points and the x -axis indicates a limiting medulla thickness of about $5\ \mu\text{m}$. Smuts et al. (1983) showed a similar graph when plotting medulla diameter against fiber diameter.

Effects of nutrition and other environmental factors on medullation

Tiffany-Castiglioni (1986) did not find studies on effects of nutrition on kemp. Effects of energy and protein intake on mohair production and quality, in general, are not well documented. A series of nutrition experiments with Angora goats was conducted at the Texas Agricultural Experiment Station, San Angelo (Calhoun, 1988). In three studies, each animal was maintained

and fed on an individual basis in a separate pen. A two-year study examined effects of various combinations of protein and energy in the diet on quantity and quality of mohair produced by 72 mature, castrated male goats (Calhoun and Lupton, 1989). A second study (Calhoun et al., 1988a), also with mature castrated male goats (36), looked specifically at effects of energy on mohair production traits; while a third study (Calhoun et al., 1988b), with intact yearling male goats (30), determined effects of frequency of protein supplementation on mohair production and quality. Individual fleeces were core-sampled and med and kemp levels were determined according to ASTM Standard Test Method D2968 (ASTM, 1989). Percentages of med and kemp fibers were unaffected by energy intake, dietary protein level and frequency of feeding a protein supplement.

Another study (Huston et al., 1990) determined effects of geographical region in Texas on mohair production and quality. This three year study involving 200 mature, castrated male goats, originally from the same flock but subsequently separated and maintained at two Texas range locations, is still in progress. However, data from six shearings indicate no significant differences between med levels (1.20 vs. 1.22%) and a small but significant ($P < 0.05$) difference between kemp levels (0.61 vs. 0.85%) for animals maintained at the two locations. Thus, an initial indication from this experiment is that environmental differences have no effect on med content and perhaps a small effect on kemp content even when other production traits (e.g., liveweight, clean mohair production and fiber diameter) are significantly affected.

In contrast, McGregor (1990) concluded that kemp and other medullated fibers in greasy and scoured mohair mid-side samples were greatly influenced by grazing management. He observed that medullated fibers generally increased with increases in stocking rate of separately grazed goats but under severe grazing pressure medullated fiber production was significantly depressed.

Another study (Lupton et al., 1986) identified effects of sex, nutrition, ageing or other environmental factors on kemp levels. In conjunction with a Texas Angora Goat Performance Test, 55 intact male goats were studied during a period in which their age increased, on average, from 11 to 15 months. Percentage of kemp in mid-side samples increased significantly ($P < 0.01$) from 0.16 to 0.29. During the same time, percentage med also showed an increasing trend from 0.81 to 1.87 (not significantly different, $P > 0.05$). These observations led to conjecture that high consumption of nutrients by those goats (compared to range-maintained animals) in the performance test contributed to increased medullation in the fleeces of these rapidly developing male animals. Further, medullated fiber levels would be expected to decrease after the animals were returned to lower nutritional levels. Based on limited observations, medullation did not decrease significantly in post-performance test fleeces of highly medullated animals maintained on rangeland for six months

or more (Shelton, personal communication, 1989). Based on observations of one exceptionally kempy animal (Bassett personal communication, 1989), the percentage of kemp measured at several body locations decreased from (on average) 27.5 to 8.1% in the six months following a performance test. Obviously, this question has yet to be fully resolved.

One other hypothesis concerning effects of nutrition on medullation was suggested by Bigham (personal communication, 1988), who had concluded from limited data that abrupt changes in type or amount of energy or protein intake might be responsible for triggering medullated fiber production.

Effect of season on medullation

Dreyer and Marincowitz (1967) reported that kemp content of autumn-shorn fleeces was higher than that in spring-shorn. This observation was made for young castrated males and does. Stapleton (1976) observed that kemp grows in a seasonal manner, more rapidly in the spring and summer and more slowly in autumn and winter. Bassett (1986) showed that percentages of kemp in a group of nine mixed-age intact males were higher in autumn-shorn samples than in samples taken in the spring (Table 1). Huston et al. (1990) re-

TABLE 1

Effect of northern hemisphere season on medullated fiber content (mean \pm SD) of Texas mohair

Shearing date	Animals	Animal age (mo)	Animal no.	Med (%)	Kemp (%)	Reference
Autumn, 1982	Intact males	Mixed	9	–	0.80 \pm 0.50	Bassett (1986)
Spring, 1983	Intact males	Mixed	9	–	0.49 \pm 0.32	
Spring, 1987	Castrated males	24	195	1.28 \pm 1.28	0.49 \pm 0.37	Huston et al.
Autumn, 1987	Castrated males	30	191	1.41 \pm 1.31	0.73 \pm 0.46	(1990)
Spring, 1988	Castrated males	36	184	1.33 \pm 1.49	0.70 \pm 0.52	
Autumn, 1988	Castrated males	42	168	0.71 \pm 0.71	0.87 \pm 0.47	
Spring, 1989	Castrated males	48	157	1.48 \pm 1.89	0.76 \pm 0.57	
Autumn, 1989	Castrated males	54	129	0.99 \pm 1.06	0.73 \pm 0.49	
Autumn, 1986	Castrated males	18	66	0.75 \pm 0.67 ^c	0.51 \pm 0.27	Calhoun &
Spring, 1987	Castrated males	24	59	2.25 \pm 1.47 ^a	0.34 \pm 0.30	Lupton
Autumn, 1987	Castrated males	30	57	0.73 \pm 0.59 ^c	0.32 \pm 0.26	(unpubl. data)
Spring, 1988	Castrated males	36	35	1.33 \pm 0.72 ^b	0.38 \pm 0.36	
Autumn, 1988	Does	18	91	0.75 \pm 1.14 ^e	0.51 \pm 0.39	Calhoun &
Spring, 1989	Does	24	96	1.71 \pm 2.87 ^d	0.49 \pm 0.40	Lupton (unpubl. data)

^{a,b,c}Means with different superscripts differ significantly ($P < 0.05$).

^{d,e}Means with different superscripts differ significantly ($P < 0.05$).

ported a general trend of autumn fleeces containing more kemp than spring fleeces although differences were not significant in this three year range study (Table 1). No trend was observed for med values during the same period. Neither med nor kemp was affected by age in this study.

In contrast to the findings of other researchers. Calhoun and Lupton (1989) showed in two separate studies that percentages of kemp were not significantly affected by season (Table 1). However, significant changes in percentages of med fiber did occur between seasons (Table 1). Percentages of med fiber were significantly higher in spring-shorn fleeces than in fleeces shorn in autumn. In both studies, animals were maintained and individually fed in pens.

Effects of disease on medullation

No specific references to effects of disease on medullation in Angora goats exist. Unusually high levels of medullation (18.4–36.9%) in five intact males in the 1988 Texas Angora Goat Performance Test led researchers (Lupton et al., 1988) to surmise that disease might be involved. In particular, Border Disease was implicated because it is known to produce highly medullated fleeces in infected lambs (Barlow and Patterson, 1982). This disease is caused by a virus that is indistinguishable from bovine viral diarrhea (BVD), which is known to be endemic in cattle in Texas, particularly prevalent in feedlots. Consequently, blood samples were drawn from five sets (two goats per set) of goats during the 1988 performance test, one of each set having been identified as producing a highly medullated fleece, and the other one being a normally medullated sibling (Table 2). Subsequently, serum samples from these animals were submitted to the Texas Veterinary Medical Diagnostic Laboratory and tested for BVD, bluetongue, chlamydia and caprine arthritis encephalitis (CAE). All tests for bluetongue and CAE were negative. Two very low

TABLE 2

Medullated fiber contents of Texas Angora Goat siblings

Highly medullated group (5 animals)		Sibling group (5 animals)	
Med content (%)	Kemp content (%)	Med content (%)	Kemp content (%)
36.1	0.8	1.5	1.2
34.5	0.3	1.0	0
33.8	2.7	4.5	0.1
25.3	0.4	0.5	0.4
17.9	0.5	0.7	0.2

Correlation coefficient of med vs. kemp for highly medullated group was 0.35; for sibling group, $r = -0.31$.

antibody titers for BVD and four for chlamydia were considered to be insignificant. All remaining animals tested negative for chlamydia and BVD. Thus, it appeared that none of these diseases was responsible for high medullated fiber levels in these test goats.

CONCLUSIONS

Medullation values in mohair are influenced by sample location and measuring technique. Samples representative of the whole fleece are most useful for objective evaluation of medullation in individual animals. Selection, using objective measurements, against medullation in Angora goats older than one year of age should be successful in reducing medullated fiber content of subsequent generations. For intact and castrated male goats maintained in individual pens, the percentages of med and kemp fibers are apparently unaffected by energy intake, dietary crude protein levels and frequency of feeding protein supplements. Other environmental factors appear to have minimal effects on medullated fiber production. Effects of season on medullation, however, are not clear and require further nutritional and physiological studies. One research project demonstrated that several diseases were not responsible for high medullation levels in male goats maintained under performance test conditions.

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