Fiber Diameter Measurements of Angora Goats on Performance Test[1,2]

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Summary

Average fiber diameter (AFD) and variability of fiber diameter (standard deviation, SD; coefficient of variation, CV) were measured on the fleeces of 301 male Angora goats participating in the 1994 and 1995 Angora Goat Performance Tests conducted by the Texas Agricultural Experiment Station. This was achieved by core-sampling each fleece and measuring a representative sub-sample using an Optical Fibre Diameter Analyser (OFDA; BSC Electronics Pty. Ltd., Attadale, Western Australia). These values were then compared to similar measurements from neck, side and britch samples that were taken halfway through the test. AFD measured on core samples were highly correlated ($r^2 > 0.65$; $P < 0.01$) with each individual and the average of the three measurements made on neck, side and britch samples. The same was true for measures of variability of fiber diameter (SD, CV). However, the variability among neck, side and britch average fiber diameter (traditionally used as an indicator of fleece uniformity) was poorly correlated ($r^2 < 0.01$) with variability of fiber diameter in the fleece core sample (CSD). It was concluded that the most accurate way to estimate the average fiber diameter and variability of a mohair fleece is to measure a representative core sample.

Key words: Angora goat, average fiber diameter (AFD), performance test, fleece sampling.

Introduction

Performance testing using objective measurements of economically important traits provides useful information for making selection decisions. The Angora Goat Performance Test was begun by the Texas Agricultural Experiment Station (TAES) in 1967, discontinued in the early 1970s and restarted in 1980. The program emphasizes the value of selecting males on their overall merit rather than focusing on a single trait (Lewis and Shelton, 1985). Since its inception, fiber diameter measurements were made on samples removed from the neck, side and britch regions about halfway through the test. This practice is rationalized as follows. Taking the samples eight weeks before the end of the test provided the lab adequate time to make all the fiber diameter measurements. This much time was necessary when a projection microscope technique was being used. Even so, a sufficient number of fibers could not be measured using a microscope to provide very accurate estimates of average fiber diameter of variability. Measuring samples taken at three distinct locations was thought to provide a good indicator of fleece uniformity. Averaging the three measurements was considered to provide a number that would be close to the true AFD of the whole fleece grown during the test period. This value was then used in the index equation for ranking animals on overall merit. In recent years, whenever one or more of the three AFD measurements exceeded 50 µm, the goat became ineligible for certification (Waldron and Lupton, 1995).

For several years, the TAES Wool and Mohair Research Lab has been equipped with instrumentation that can measure mohair AFD and distribution much more rapidly and accurately than the projection microscope (when relatively few fibers were measured). Thus, the requirement of sampling at the midpoint of the test is no longer necessary. Fleeces grown

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during the test period can now be fully quantified in terms of yield, AFD and medullated fibers in less than three weeks.

In both years of the experiment, animals were managed and fed in an identical manner. It was of interest to determine if and to what extent other environmental factors might affect the various measures of AFD. However, the experiment was designed primarily to establish the relationships among AFD measured on the neck, side, britch and whole fleeces, as well as to compare variability of fiber diameter in the whole fleece to those measures of variability determined for the neck, side and britch samples and the traditional indicator of variability (i.e., variation among neck, side and britch AFD).

Materials and Methods

Mohair patch samples (approximately 3 in × 3 in) were removed from the neck, side and britch regions of each yearling goat participating in the 1994 and 1995 Angora Goat Performance Tests conducted at the TAES Sonora facility. Each sample (representing eight weeks of mohair growth) was subsampled close to the base of the staple, cleaned, conditioned and measured for AFD, and SD and CV of fiber diameter. Subsequently, 112-day fleeces were shorn from the animals and cored (with 32.5-in coring tubes) to obtain a sample representative of the whole fleece (Johnson and Larsen, 1978). This sample was cleaned in a standard manner (ASTM, 1995), conditioned and measured for AFD, SD and CV. The Optical Fibre Diameter Analyser was used to make all the measurements in both years of the experiment (IWTO, 1995).

For the analysis, it was assumed that all goats were genetically independent of each other. In fact, this was not the case. Although several goats had common sires, we considered that these few relationships would not significantly affect the results of our analyses. Data were analyzed to provide simple statistics (mean, SD and CV) for each variable measured. In addition, paired T tests, simple linear regression analyses and analyses of variance were performed on the data using the MEANS, REG and GLM procedures of SAS (SAS, 1992).

Results and Discussion

Data from the 301 animals completing the 1994 and 1995 performance tests were analyzed. A summary of the simple statistics is given in Table 1. Overall, the AFD of the fleece core samples (CAFD) was not different ($P = 0.13$) than that of the side samples (SAFD). However, CAFD was 1.5 µm smaller ($P < 0.0001$) than AFD of the neck samples (NAFD), 4.6 µm smaller ($P < 0.0001$) than AFD of the britch samples (BAFB) and 2.0 µm smaller ($P < 0.0001$) than the mean AFD of the neck, side and britch samples (AAFD). The last value (AAFD) is that used in the index equation to rank animals. As expected, the variability of fiber diameter in the core sample (CV) was greater ($P < 0.0001$) than in either the neck or side samples. However, it was comparable in magnitude (27.6 vs. 28.0%, $P = 0.16$) to that measured for mohair growing in the britch region. This study confirms that mohair fibers from the britch of Angora goats are the coarsest and most variable tested.

In terms of year differences, all 1994 AFD and SD of fiber diameter were greater than comparable measurements made in 1995 ($P < 0.002$; Table 2). CV of fiber diameter were unaffected by year ($P > 0.26$).

Table 3 and Figure 1 show that CAFD and AAFD are highly corre-

Table 1. Minimum and maximum values, means and standard deviations for core, neck, side and britch average fiber diameters (AFD), standard deviations (SD) and coefficients of variation (CV) of fiber diameter.

Items	Min.	Max.	Mean	SD
Core:				
AFD, µm	29.5	57.0	39.9	3.9
SD, µm	7.8	17.2	11.0	1.6
CV, %	20.7	37.5	27.6	2.9
Neck:				
AFD, µm	28.1	59.4	41.4	5.3
SD, µm	6.1	17.4	10.2	2.0
CV, %	16.5	39.3	24.7	4.0
Side:				
AFD, µm	27.0	56.3	39.7	4.9
SD, µm	6.1	17.3	9.5	1.7
CV, %	15.9	36.7	24.1	3.8
Britch:				
AFD, µm	28.9	64.0	44.5	5.9
SD, µm	6.9	22.7	12.3	2.4
CV, %	17.0	51.6	28.0	5.6
Average of neck, side and britch:				
AFD, µm	28.0	59.0	41.9	5.1
SD, µm	6.5	18.7	10.7	1.8
CV, %	17.9	38.0	25.6	3.9

lated. More than 84% of the variation in CAFD can be accounted for by the variation in AAFD. The CAFD is also significantly correlated with SAFD, NAFD and BAFD (r^2 = 0.8190, 0.7785 and 0.6673, respectively). Any one of these measures of AFD could be used to give a fair estimate of CAFD, but AAFD would give a better estimate than any of the three individual measures. Nevertheless, such an estimate would not be perfect (because $r^2 \neq 1$) and CAFD is best determined by direct measurement.

Variability of fiber diameter in the core samples is quantified by CSD and CCV. The CSD values are significantly correlated with average standard deviation of diameter values measured on neck, side and britch samples (ASD; r^2 = 0.6679, Figure 2). The correlation between CCV and ACV is also quite high (r^2 = 0.6040). However, because the correlations are not perfect, the best estimate of variability of fiber diameter in the whole fleece is also that determined by direct measurement.

In the past, neither ASD nor ACV values have been available in the performance test report. A more tradi-

Table 2. Differences in average fiber diameter and distributions between years, and its statistical significance (P).

Items	1994	1995	P
Core:			
AFD, µm	40.7	39.3	0.0016
SD, µm	11.3	10.8	0.0015
CV, %	27.8	27.4	0.2597
Neck:			
AFD, µm	42.9	40.2	0.0001
SD, µm	10.7	9.8	0.0001
CV, %	25.0	24.5	0.2711
Side:			
AFD, µm	40.8	38.9	0.0004
SD, µm	9.9	9.2	0.0008
CV, %	24.3	23.9	0.3952
Britch:			
AFD, µm	46.1	43.2	0.0001
SD, µm	12.8	11.9	0.0005
CV, %	28.1	27.9	0.7322
Average of neck, side and britch:			
AFD, µm	43.3	40.7	0.0001
SD, µm	11.1	10.3	0.0001
CV, %	25.8	25.4	0.4222

Table 3. Linear relationships between various measures of average fiber diameter (AFD) and variability of fiber diameter.

Dependent variable		Intercept		Slope		Independent variable	r^2
CAFD[b]	=	10.03	+	0.71	×	AAFD[c]	0.8461
CAFD[b]	=	13.05	+	0.65	×	NAFD[d]	0.7785
CAFD[b]	=	10.89	+	0.73	×	SAFD[e]	0.8190
CAFD[b]	=	15.89	+	0.54	×	BAFD[f]	0.6673
CSD[g]	=	3.41	+	0.71	×	ASD[h]	0.6679
CSD[g]	=	10.82	+	0.08	×	STD[i]	0.0049
CCV[j]	=	13.15	+	0.56	×	ACV[k]	0.6040

r^2 = coefficient of determination.
CAFD = average fiber diameter of the fleece core sample.
AAFD = average of the neck, side and britch average fiber diameters.
NAFD = average fiber diameter of the neck sample.
SAFD = average fiber diameter of the side sample.
BAFD = average fiber diameter of the britch sample.
CSD = standard deviation of fiber diameter of the fleece core sample.
ASD = average of the neck, side and britch standard deviations of fiber diameter.
STD = standard deviation of the neck, side and britch average fiber diameters.
CCV = coefficient of variation of fiber diameter of the fleece core sample.
ACV = average of the neck, side and britch coefficients of variation of fiber diameter.

tional method of gauging variability (or uniformity) of mohair fiber diameter in these test animals has been to mentally compare the neck, side and britch AFD. Table 2 and Figure 3 show that the correlation between actual variability of fiber diameter in the fleece (CSD) and the variability among neck, side and britch average fiber diameters (STD) is very low. In other words, comparing the AFD of the neck, side and britch sample is a very poor method of estimating fiber diameter variability in the fleece as a whole. The CSD is calculated from measurements on fibers obtained in a manner so as to be representative of the entire fleece. The STD cannot separate bucks that have a small area of coarse fiber from those that have a large area of coarse fiber because data used to calculate STD were generated from measurements made on three small patches.

Conclusions

The overall AFD of the fleece core samples and side samples were not different. However, neck, britch and the average of neck, side and britch AFD were all greater than the core sample AFD.

AFD measured on core samples were highly and significantly correlated with each individual and the average of the three measurements made on neck, side and britch samples. The same was true for measures of fiber diameter variability.

The variability among neck, side, and britch AFD was poorly correlated with variability of fiber diameter in the fleece core sample.

The most accurate way to estimate the AFD and variability of a mohair fleece is to measure a representative core sample.

Implications

Procedures of several Angora goat performance tests in this country (Oklahoma) and abroad (Canada, New Zealand, Australia) have been based on those developed and used by the Texas Agricultural Experiment Station. Assuming that high-speed measurement of fiber diameter is available, sampling mohair at three

Figure 1. Average of fiber diameter at three locations (AAFD) versus core sample average fiber diameter (CAFD).

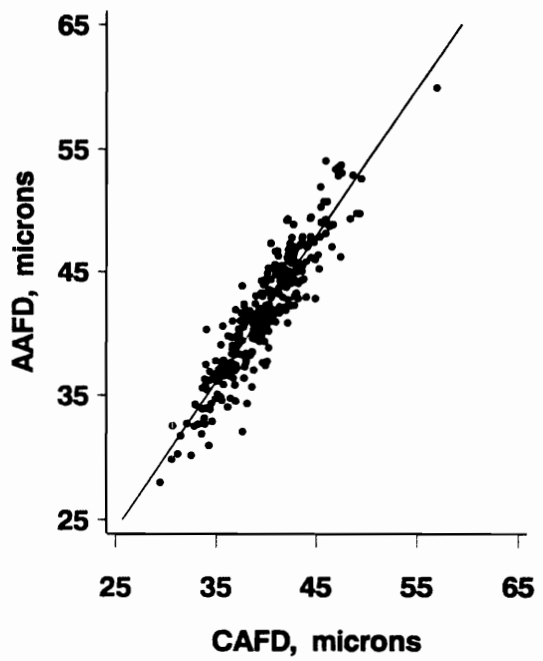
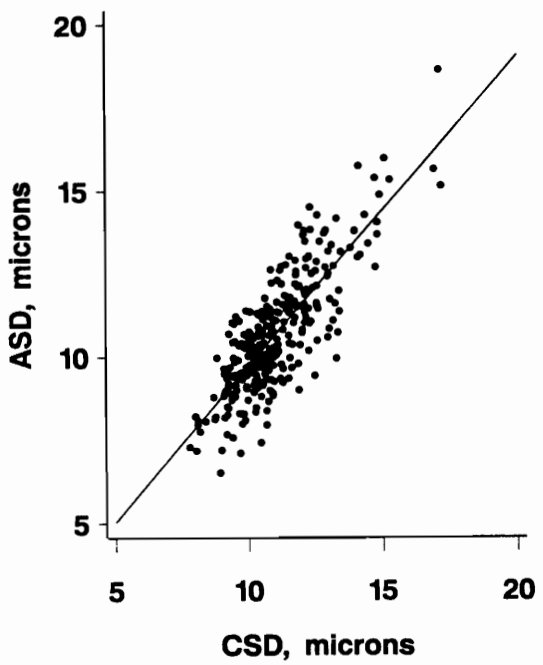


Figure 2. Average of standard deviation of fiber diameter at three locations (ASD) versus core sample standard deviation (CSD).



body locations part-way through the performance test can no longer be justified. Measuring a core sample of the fleece shorn at the end of the test period provides the most accurate estimates of AFD and variability of fiber diameter within the fleece.

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Figure 3. Standard deviation of average fiber diameter (AFD) for three locations (STD) versus core sample standard deviation of fiber diameter (CSD).