Morphological Composition of Wool of Tuvan Coarse-Wooled Breeding Goats

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Abstract. The aim of this article was to determine the morphometric properties of wool coat in relation to weight and age of animals. The objects of the study were Tuvan coarse-wooled bucks from farms located in the Republic of Tyva (Russia) on the border with Mongolia. Goat wool samples were taken from the side behind the scapula for examination using an OFDA 2000 optical hair diameter analyzer. It was found that there is no correlation between body weight and down length, with down length having a correlation with total wool length at the 0.48 level. The average diameter of the fibers in the staple correlates positively with the peak value of the histogram (0.47), while the dependence of down length on its diameter is weakly negative (–0.19). It was found that there are animals in the population with a down hair length of more than 7 cm, and with a histogram peak of 16 μm. We believe that there is genetic potential in the population of aboriginal Tuvinian coarse-wooled goats to create herds with down productivity with fine down (cashmere) free from transitional type fibers and satisfying industry requirements in terms of length.

1. Introduction

For the rural population of the Tyva Republic goat breeding is a traditional branch of livestock breeding and according to Chikalev A.I. and T.B. Kargachakova, the region ranks first in Russia by the number of goats, while the Republic of Dagestan and Altai rank second and third, respectively [1].

The main goat population in Tyva is represented by the Soviet wool breed and populations of local Tuvinian coarse-wooled goats. Local coarse-wooled goats are unpretentious, have a strong constitution, and are well adapted to the sharply continental climate [2]. At the same time, the climate in the south-eastern part of the Tyva Republic is very harsh – in winter, which lasts about 180 days, the average temperature is minus 30 °С and can fall to –60 °С. In summer, the temperature averages around +18 °С, while the maximum temperature is +40 °С. The elevation is 1102 m above sea level [3].

According to Beketov S.V. et al., the Tuvinian native goat population is genetically divided between two main groups, one of which combines predominantly Mongolian native populations and the other – Central Asian breeds [4].
Chysyma R.B., Makarova E.Y., Deeva V.S., as a result of the studies conducted, also came to a conclusion about the peculiarity of the gene pool of Tuvinian coarse-wooled goats. At the same time, they have an average living mass of 67.35 ± 2.45 kg in bucks, and 48.50 ± 0.62 kg in does [5]. The fecundity of Tuvinian indigenous goats is 120% [6]. Having good adaptability to the distant-mountain pasture keeping, good meat productivity and long productive longevity, aboriginal goats are the carriers of the reserve of valuable hereditary qualities [7].

It should be noted that one of the additional resources for increasing the profitability of goat breeding is the production of down. In the Russian Federation, 3 down breeds and a breed group are currently being bred, with special attention in breeding for down thinning [8]. It is connected to the fact that in spite of the fact that the down cover of goats with fine down (cashmere) is 15.8 % and the down length is 4.97 % lower in comparison with goats with coarse down (cashgora), such decrease is economically justified, as the cashgora down in the international market costs 3–4 times less than the cashmere down. Besides down, according to Kargachakov T.B. and Chikalev A.I., in breeding goats it is necessary to strive to eliminate transitional hair in the wool cover, which will improve product quality due to the gap between the timing of molting of down and flax [9].

Signs of down productivity in goats include natural and true length, fineness, strength of down and beard hairs, as well as down and fluff content in wool [10]. For this reason, different lines are formed when breeding goats: high down density, high live weight, high fleece and high down length, with relatively thin down, high fleece [11].

Thus, in order to carry out full-fledged breeding work in aboriginal populations, it is necessary to develop productivity parameters for their selection. Therefore, it is of certain scientific and practical interest to study the productive indicators of Tuvinian coarse-wooled breeding goats. The aim of our research was to determine the morphometric indicators of the wool coat in correlation with the weight in animals of productive age.

2. Materials and methods
The objects of the research were Tuvinian rough-wooled goat breeders no. 6387, 6479, 6489, 6133, 6471, 6187, 6145, 6412, 6285, 6280, 6171 from SPK “Uurgai” located in the southeast part of the Tuva Republic, and also no. 6309, 5062, 6220 from SPK “Torgalyg” located in the southwest of the republic. Both areas border Mongolia to the south. The farms are 200 km away from each other.

Animals in April 2021 had their live weight measured by individual weighing after 15 hours of fasting with an accuracy of 0.1 kg during valuation. Wool samples were taken from the side behind the scapula for examination using an OFDA 2000 optical fiber diameter analyzer. The diameter of fibers was determined by making a cut at a distance of 0.5 cm from the bottom of the staple. In the same area, the natural length of down and beard hair was measured with a ruler to the nearest 0.5 cm. The obtained numerical data were processed using Microsoft Excel 2007 statistical analysis package.

3. Research results
As a result of the studies conducted, it was found that the weight of breeding goats has a fairly wide range from 44.2 to 70.2 kg, with the weight of animals at the age of 2 years lower than that of older goats (table 1).

It should be noted that by body weight this sample of animals is quite consolidated (Cv=9.9). Total wool length and down length are more variable at 22.0% and 23.9%, respectively. The breeding male goats no. 6489 and no. 6220 have a down length of 7 and 8 cm, which corresponds to the desirable type for goats with downy performance. This down length is well suited to industry requirements, since the combed spinning system uses a down length of 7.1 cm or more. Calculation of the correlation between weight and total wool length is 0.52 and 0.06, indicating no relationship between body weight and down length, with down length having a relationship with total wool length of 0.48.
### Table 1. Live weight and wool length of Tuvinian coarse-wooled breeding goats.

| Individual animal number | Age, years | Live weight, kg | Length of the beard hair, cm | Down zone length, cm |
|--------------------------|------------|-----------------|------------------------------|----------------------|
| 6387                     | 4          | 61.0            | 9                            | 4                    |
| 6479                     | 3          | 63.3*           | 14*                          | 6*                   |
| 6489                     | 3          | 61.6            | 11                           | 7*                   |
| 6133                     | 3          | 63.5*           | 12                           | 4                    |
| 6471                     | 3          | 61.4            | 14*                          | 5                    |
| 6187                     | 3          | 64.8*           | 11                           | 4                    |
| 6145                     | 3          | 59.7            | 9                            | 5                    |
| 6412                     | 3          | 64.2*           | 14*                          | 5                    |
| 6285                     | 2          | 44.2            | 9                            | 4                    |
| 6280                     | 2          | 56.3            | 12                           | 5                    |
| 6171                     | 2          | 60.0            | 12                           | 5                    |
| 6309                     | 4          | 70.2*           | 13*                          | 4                    |
| 5062                     | 4          | 68.1*           | 19*                          | 6*                   |
| 6220                     | 2          | 59.0            | 15*                          | 8*                   |

\[ M±m = 61.24±1.627 \quad 12.43±0.732 \quad 5.14±0.329 \]

\[ \text{lim} = 44.20-70.20 \quad 9.00-19.00 \quad 4.00-8.00 \]

\[ \text{Cv} = 9.9 \quad 22.0 \quad 23.9 \]

* - indicators that are above average

The number of fibers with different diameters is shown in the fragments of histograms (figures 1–4), constructed based on the results of wool staple study on the OFDA 2000 device. In breeding goats no. 6309 (figure 1) and no. 6489 (figure 3) the amount of transitional hair (30.1–52.5 µm) is insignificant, while in breeding goats no. 6387 (figure 2) and no. 6145 (figure 4) this type of hair is present in significant amounts. Also, the peak of the histogram can show us the diameter that most fibers have.

**Figure 1.** Fragment of the histogram of a breeding goat no. 6309.

**Figure 2.** Fragment of the histogram of a breeding goat no. 6387.
Figure 3. Fragment of the histogram of a breeding goat no. 6489.

Figure 4. Fragment of the histogram of a breeding goat no. 6145.

The results of wool samples examination on the OFDA 2000 device are shown in Table 2 in more detail. The most consistent indicator, according to the calculations, is the percentage of down fibres in the staple. This rate averaged 85.0±1.23%, with a maximum value of 94.15% and Cv=5.4.

Table 2. Morphological composition of wool fibers of Tuvan coarse-wooled breeding goats, microns.

| Animal number | Wool fiber content in the sample, % | Average fiber diameter in the sample | Thinness at the peak of the histogram |
|---------------|------------------------------------|-------------------------------------|--------------------------------------|
|               | down (up to 30)                     | transition beard hair (30.1 - 52.5) | total                                |
|               | (52.6 - 75.0)                       | (75.1 - 90.0)                       | (90.1 or more)                      |
| 6387          | 78.5                                | 9.73                                | 11.77                                | 4.66                                 | 3.83                                 | 3.28                                 | 28.03                                 | 17                                    |
| 6479          | 85.21                               | 6.37                                | 8.42                                | 1.29                                 | 0.73                                 | 6.40                                 | 7.05                                 | 28.58                                 | 19                                    |
| 6489          | 81.36                               | 1.99                                | 16.65                               | 3.20                                 | 6.40                                 | 7.05                                 | 29.54                                 | 16                                    |
| 6133          | 82.25                               | 9.35                                | 8.40                                | 3.44                                 | 1.51                                 | 3.45                                 | 25.39                                 | 17                                    |
| 6471          | 78.20                               | 2.32                                | 19.48                               | 2.06                                 | 2.65                                 | 14.77                                | 36.23                                 | 18                                    |
| 6187          | 89.32                               | 0.41                                | 10.27                               | 3.04                                 | 4.14                                 | 3.09                                 | 24.79                                 | 17                                    |
| 6145          | 84.25                               | 3.62                                | 12.13                               | 8.47                                 | 3.47                                 | 0.20                                 | 25.01                                 | 16                                    |
| 6412          | 89.75                               | 0.74                                | 9.51                                | 6.49                                 | 1.92                                 | 1.09                                 | 24.00                                 | 16                                    |
| 6285          | 87.23                               | 6.38                                | 6.38                                | 0.41                                 | 0.78                                 | 5.19                                 | 28.73                                 | 21                                    |
| 6280          | 83.44                               | 4.85                                | 11.71                               | 5.85                                 | 3.61                                 | 2.24                                 | 27.26                                 | 16                                    |
| 6171          | 89.47                               | 1.96                                | 8.56                                | 6.82                                 | 1.09                                 | 0.65                                 | 23.18                                 | 16                                    |
| 6309          | 81.18                               | 1.16                                | 17.66                               | 3.77                                 | 6.19                                 | 7.69                                 | 32.88                                 | 20                                    |
| 5062          | 85.68                               | 3.67                                | 10.64                               | 0.31                                 | 0.83                                 | 9.50                                 | 25.03                                 | 17                                    |
| 6220          | 94.15                               | 1.35                                | 4.49                                | 1.69                                 | 1.51                                 | 1.29                                 | 22.62                                 | 18                                    |
Distribution of fibers depending on thinness over other groups (transitional, terminal) has individual character at animals as in this case $C_v$ has value from 38.23 to 86.5. Particularly important in terms of clean down are the minimum values for transitional hair in the animals, in this respect the best indicator has the breeding goat no. 6187 (0.41%). In terms of selecting animals for downy fiber thinning, the fiber diameter at the peak of the histogram is an important indicator and in 5 animals it is at the level of 16 $\mu$m.

The calculations showed that the average diameter of fibers in the staple does not depend on animal weight (correlation coefficient 0.04), but positively related to the peak value of the histogram (0.47), and the dependence of down length on its diameter is weakly negative ($-0.19$).

Table 3 presents data on live weight, down zone length and other productivity indices for which breeding goats show indices that differ from the average in the direction desirable for breeding.

| animal number | Age, years | Live weight, kg | Down zone length, cm | Content, % down (0-30 $\mu$m) | Content, % transitional hair (30.1-52.5 $\mu$m) | Thinness at the histogram peak, $\mu$m |
|---------------|------------|-----------------|----------------------|---------------------------------|-----------------------------------------------|---------------------------------------|
| 6387          | 4          | 63.3            | 6                    | 17                             | 17                                           | 17                                    |
| 6479          | 3          | 63.3            | 6                    | 1.99                            | 16                                           | 16                                    |
| 6489          | 3          | 63.5            | 7                    | 2.32                            | 17                                           | 17                                    |
| 6133          | 3          | 64.8            | 89.32                | 0.41                            | 16                                           | 16                                    |
| 6412          | 3          | 64.2            | 89.75                | 0.74                            | 16                                           | 16                                    |
| 6285          | 2          | 87.23           |                      |                                 |                                               |                                       |
| 6280          | 2          | 89.47           |                      | 1.96                            | 16                                           | 16                                    |
| 6309          | 4          | 70.2            |                      | 1.16                            |                                               |                                       |
| 5062          | 4          | 68.1            |                      |                                 |                                               | 17                                    |
| 6220          | 2          | 89.41           |                      | 1.35                            |                                               |                                       |

Analysis of the data presented in table 3 indicates that only one desirable trait was identified in four goats, while the maximum number of traits (four) was identified in two animals, and all traits were not identified in any animal. It should be noted that one of the most important traits for goat down performance, down length, is quite pronounced in the two goats, with a combination of low transitional hair and fine down in goat breeder no. 6489.

4. Conclusion

Thus, as a result of the conducted studies of morphometric indicators of wool of breeding goat, it is established that in the population of aboriginal Tuvinian coarse-wooled goats there is genetic potential for creating herds with down productivity with fine down (cashmere) meeting the industry requirements in length and free from transitional type fibers.
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