Live weight and Coat Length of Tuvan Coarse-Haired Goats

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Abstract. The research purpose was to determine the morphometric parameters of the coat in animals of productive age. The objects of the study were Tuvan coarse-haired goats at the age of 3 years (n = 20) from the agricultural enterprise “Uurgai” located in the southeastern part of the Republic of Tyva (Russia) bordering Mongolia in the south. Wool samples were taken from the animals from the side behind the shoulder blade for examination using an optical fiber diameter analyzer OFDA 2000. It was found that the length of the down averaged 6.35 ± 0.45 cm (Cv = 31.6). The down in the studied goats is shorter than the covering hair and in 35% of the animals studied it exceeds the length of 7 cm. As a result of wool studies using the optical fiber diameter analyzer OFDA 2000, it was found that the proportion of down hair (less than 30 μm) averages 80.21 ± 1.57% (Cv = 8.8), with a fairly significant difference between the extreme values from 67.52 to 90.84%. The amount of transitional hairs has critical differences from 2.28 to 19.42% at Cv = 64.6, while in animals with a low content of transitional hair in the staple (2.28–4.14%), the peak of the diagram has a value within 15–17 μm with a correlation coefficient of 0.69. The data obtained allows for the following conclusion: in order to obtain high-quality down with the smallest fiber diameter when breeding native Tuvan coarse-wooled goat, special attention should be paid to the presence of a transitional hair type (30.1–52.5 μm) in addition to the length of the down and its diameter.

1. Introduction
The world population of goats is 800 million head and 560 breeds, accounting for 12% of the total number of recorded mammalian breeds. They are one of the most adaptable livestock species on all continents [1]. They supply milk, meat and wool for human needs, while surviving on scarce feed and in harsh environmental conditions [2].

Breeding downy goats is most economically feasible if the fiber obtained from them is less than 19 microns in diameter. This down is classified as cashmere. The most expensive down is obtained from goats of the Changthangi breed; it has an average diameter of 10–14 microns. Such properties appear due, inter alia, to the conditions of keeping animals: the height of pasture lands above sea level (3700–4500 m) and their quality, cold and arid climate, significant seasonal and daily temperature fluctuations (from plus 35 °C to minus 40 °C) [3].
The world production of cashmere in 2012 compared to 1991 increased by 4 times and amounted to 20,000 tons. At the same time, the production of mohair, on the contrary, decreased. The main cashmere producer is China (70%), followed by Mongolia (20%). The rest of the production of goat down is concentrated in Iran, Afghanistan, the former republics of the USSR, India, Turkey and Pakistan [4].

In Russia, Republic of Tyva holds the first place in terms of the number of goats [5]. The main livestock is represented by the Soviet wool breed and populations of local Tuvan coarse-wool goats. Aboriginal coarse-haired goats are unpretentious, have a strong constitution, and are well adapted to the sharply continental climate [6]. At the same time, the climate in the southeastern part of Republic of Tyva is very harsh – in winter, which lasts about 180 days, the average temperature is minus 30 °C and can drop to minus 60 °C. In summer, the average temperature is +18 °C, and the maximum is +40 °C. The height above sea level is 1102 m [7]. According to S.V. Beketov et al. [8], the population of the Tuvan local goat is genetically divided into two main groups; in one of them mainly Mongolian aboriginal populations are combined, and in another – Central Asian breeds. The researchers R.B. Chysyma, E.Yu. Makarova, and V.S. Deeva [9] come to the conclusion that the gene pool of Tuvan coarse-haired goats is unique. These goats have an average live weight of 67.35 ± 2.45 kg in goats-breeders and 48.50 ± 0.62 kg in female goats. Fertility of Tuvan aboriginal goats is 120% [10]. According to I.L. Masoni [11], all significant goat breeds from which cashmere is obtained belong to the same group called Central Asian goats.

Currently, there is a tendency to abandon the unique qualities of aboriginal animals in favor of highly productive specialized breeds. However, at the same time, it is clear that the strategy of preserving genetic diversity within and between breeds allows avoiding further loss of genetic resources [12].

In local populations, selection is increasing, it is accompanied by the standardization of traits, whereas the uncontrolled reproduction among breeds is seriously reduced, which leads to the fragmentation of the original gene pools. Artificial insemination has led to the emergence of several industrial breeds with high productivity in some specific traits, low reproduction rates and profound phenotypic changes [13].

Thus, in order to conduct full-fledged breeding work in aboriginal populations, it is necessary to develop parameters for their selection in terms of productivity. In this regard, the study of the productive indicators of Tuvan coarse-haired goats is relevant. The given research purpose was to determine the morphometric parameters of the coat in animals of productive age.

2. Materials and methods
The research objects were Tuvan coarse-haired goats at the age of 3 years (n = 20) from the AE “Uurgai” located in the southeastern part of the Republic of Tyva (Russia), which borders Mongolia in the south.

Animals’ live weight was measured in April 2021 during appraisal by individual weighing after a 15-hour fasting with an accuracy of 0.1 kg. Wool samples for research purpose were taken from the side behind the blade using an OFDA 2000 optical fiber diameter analyzer. The fiber diameter was determined by making a cut at a distance of 0.5 cm from the bottom of the staple. In the staple, the natural length of the down and guard hairs were measured with a ruler accurate to 0.5 cm. The obtained digital data were processed using the Microsoft Excel 2007 statistical analysis package.

3. Research results
The research showed that the mass of goats varies within a fairly wide range from 32.7 to 45.5 kg, while in most animals the mass is close to the average for the group (39.46 ± 0.86 kg). The consolidation of the herd of goats according to this indicator is evidenced by a rather low indicator of variability $Cv = 9.2$ (table 1).
Table 1. Live weight and hair length of Tuvan coarse-haired goats.

| The animal’s individual registration number | Live weight, kg | Guard hair length, cm (GL) | Down hair length, cm (DL) | DL/GL* |
|--------------------------------------------|----------------|---------------------------|--------------------------|--------|
| 1593                                       | 41.0           | 10                        | 5                        | 0.50   |
| 1917                                       | 36.5           | 12                        | 11                       | 0.92   |
| 1697                                       | 32.7           | 10                        | 8                        | 0.80   |
| 1770                                       | 38.0           | 14                        | 9                        | 0.64   |
| 1552                                       | 36.5           | 13                        | 9                        | 0.69   |
| 1726                                       | 42.5           | 11                        | 6                        | 0.55   |
| 1998                                       | 41.5           | 5                         | 4                        | 0.80   |
| 1905                                       | 40.5           | 6                         | 4                        | 0.67   |
| 1760                                       | 34.0           | 12                        | 6                        | 0.50   |
| 1963                                       | 43.2           | 12                        | 5                        | 0.42   |
| 1869                                       | 40.0           | 12                        | 7                        | 0.58   |
| 1602                                       | 39.0           | 11                        | 8                        | 0.73   |
| 1886                                       | 44.0           | 14                        | 9                        | 0.64   |
| 1532                                       | 37.5           | 12                        | 5                        | 0.42   |
| 1698                                       | 38.0           | 9                         | 4                        | 0.44   |
| 1696                                       | 45.5           | 10                        | 6                        | 0.60   |
| 1588                                       | 33.5           | 8                         | 6                        | 0.75   |
| 1839                                       | 41.5           | 12                        | 5                        | 0.42   |
| 1764                                       | 40.4           | 6                         | 5                        | 0.83   |
| 1996                                       | 42.0           | 12                        | 5                        | 0.42   |
| M±m                                        | 39.46±0.86     | 10.55±0.58                | 6.35±0.45                | 0.62±0.035 |
| lim                                         | 32.7–45.5      | 5.0–14.0                  | 4.0–11.0                 | 0.42–0.92 |
| Cv                                          | 9.2            | 24.5                      | 31.6                     | 25.5   |

* – the ratio of the length of downy hair to the length of the guard hair

Analysis of the data on the length of wool fibers, both guard and down, suggests that there is no purposeful selection of animals in the herd according to these indicators. Their variability is 24.5 and 31.6%, respectively. Also, such an indicator as the ratio of the length of the down to the length of the guard hair is scattered significantly; despite the fact that on average this indicator is 0.62, in some animals it reaches 0.8–0.92. Also, such ratio can be the same both in goats with relatively long hair (11–12 cm) and short-haired goats (5–6 cm). In general, it should be noted that the correlation coefficient between the length of down and guard fibers is at the level of 0.6; as for the correlation between the mass of the animal and the length of the down, this value is slightly negative and amounts to −0.22. Also, a weak negative correlation is observed between the length of the down and the peak of the histogram, which in goats is located in the area of down hair (up to 30 μm) (figures 1–6).
Figure 1. Fragment of a histogram of a no. 1552 goat.

Figure 2. Fragment of a histogram of a no. 1602 goat.

Figure 3. Fragment of a histogram of a no. 1532 goat.

Figure 4. Fragment of a histogram of a no. 1886 goat.
Figures 1–3 show fragments of histograms obtained when examining wool with an optical fiber diameter analyzer OFDA 2000, it shows that most of the fibers have a diameter of 8 to 30 μm, and fibers with a diameter of 31 to 52 μm are present in insignificant amounts of 2.28–4.28 % of the total (table 2). Despite the general similarity of histograms in no. 1532 goat, the down has a larger average diameter, since the most fibers have a diameter of 19 μm, while in no. 1552 and no. 1602 goats this indicator is 15 μm.

Figures 4–6 show fragments of histograms of the distribution of wool fibers by diameter, which are not desirable for goats from which it is planned to obtain down with an average fiber diameter of less than 19 μm, since these animals have a pronounced zone of transitional hair located in the range of 31–52 microns. The distribution of fibers according to the type of no. 1963 and no. 1698 goats is most typical for animals, with a gradual decrease in the number of fibers with an increase in their diameter; at the same time, there are individuals (no. 1886), which have a histogram peak in the area of transitional hairs close in quantitative value to the peak in the down area.

A more detailed analysis of the histograms presented in table 2 brings to the conclusion that the ratio of down, transitional and guard hairs is 8:1:1 in terms of quantity, however, the most desirable type for down productivity is the ratio found in no. 1552 goat, which looks like 39:1:3.5.

**Table 2.** Morphological composition of wool fibers of Tuvan coarse-haired goats, μm.

| Animal No | down (up to 30) | transitional hair (30.1–52.5) | spine (more than 52.6) |
|-----------|----------------|-------------------------------|------------------------|
|           |                | total                         | fine (52.6–75.0)       | average (75.1–90.0) | rough (90.1 and more) |
| 1593      | 81.72          | 4.14                          | 14.14                  | 3.73                 | 3.45                  | 7.12                  | 30.40 | 16    |
| 1917      | 75.63          | 10.71                         | 13.66                  | 2.40                 | 3.28                 | 7.97                  | 33.09 | 19    |
| 1697      | 80.80          | 3.49                          | 15.70                  | 9.97                 | 4.33                 | 1.03                  | 27.89 | 17    |
| 1770      | 78.09          | 13.14                         | 8.77                   | 1.98                 | 2.13                 | 4.74                  | 29.82 | 19    |
| 1552      | 89.77          | 2.28                          | 7.95                   | 5.53                 | 1.59                 | 0.72                  | 22.34 | 15    |
| 1726      | 70.47          | 19.42                         | 10.11                  | 3.80                 | 3.26                 | 2.92                  | 31.32 | 23    |
| 1998      | 79.32          | 5.31                          | 15.36                  | 5.12                 | 3.81                 | 6.35                  | 32.48 | 20    |
Table 2. Morphological composition of wool fibers of Tuvan coarse-haired goats, μm.

| Animal No | down (up to 30) | transition (30.1–52.5) | spine (more than 52.6) | Average fiber diameter in the sample | Fineness at the peak of the histogram |
|-----------|----------------|------------------------|------------------------|-------------------------------------|--------------------------------------|
|           |                | total                  | fine (52.6–75.0)       | average (75.1–90.0)                 |                                      |
| 1905      | 89.12          | 4.70                   | 6.18                   | 5.05                                | 0.49                                 | 0.62                                 | 23.16 | 17 |
| 1760      | 80.68          | 8.29                   | 11.03                  | 6.17                                | 3.47                                 | 1.35                                 | 28.32 | 20 |
| 1963      | 72.53          | 18.06                  | 9.41                   | 3.10                                | 2.50                                 | 3.76                                 | 31.21 | 23 |
| 1869      | 69.64          | 18.33                  | 12.03                  | 3.11                                | 3.64                                 | 5.27                                 | 32.47 | 21 |
| 1602      | 90.84          | 4.22                   | 4.94                   | 4.71                                | 0.17                                 | 0.06                                 | 21.28 | 15 |
| 1886      | 67.52          | 19.41                  | 13.07                  | 8.35                                | 2.55                                 | 2.36                                 | 31.16 | 17 |
| 1532      | 85.80          | 4.28                   | 9.92                   | 5.91                                | 3.10                                 | 0.89                                 | 26.40 | 19 |
| 1698      | 75.21          | 11.56                  | 13.23                  | 4.67                                | 5.27                                 | 3.28                                 | 31.17 | 20 |
| 1696      | 89.12          | 3.28                   | 7.60                   | 5.67                                | 3.00                                 | 0.32                                 | 23.60 | 16 |
| 1588      | 82.86          | 7.10                   | 10.05                  | 1.87                                | 4.65                                 | 2.80                                 | 26.80 | 18 |
| 1839      | 76.13          | 8.29                   | 15.58                  | 6.74                                | 3.75                                 | 3.77                                 | 30.68 | 19 |
| 1764      | 86.05          | 9.26                   | 4.69                   | 4.09                                | 0.99                                 | 0.11                                 | 23.78 | 17 |
| 1996      | 82.99          | 4.91                   | 12.10                  | 6.62                                | 3.52                                 | 2.32                                 | 28.19 | 18 |

Thus, the lower the transitional hair, the higher the yield of pure down and the better its fineness is. In general, in terms of the share of down hair, the studied herd is quite consolidated (Cv = 8.8), despite a rather significant spread of extreme values ranging from 67.52 to 90.84 %. At the same time, the data on the amount of transitional hair have critical differences from 2.28 to 19.42 % at Cv = 64.6, which indicates that when choosing animals for selection in a given herd, special attention should be paid to this trait. Also, animals have significant individual characteristics in terms of the number and size of the guard hair diameter.

It should be noted that in animals with a low content of transitional hair in the staple (2.28–4.14 %), the peak of the diagram has a value in the range of 15–17 microns, while with the amount of transitional hairs 18.06–19.42 %, the hair diameter at the peak of the histogram is 17–23 μm, and this direct relationship is confirmed by the correlation coefficient, which is 0.69. The diameter value at the peak of the histogram with the percentage of fibers having a diameter less than 30 μm has an inverse correlation of – 0.71. By the peak of the histogram, one can indirectly judge the average diameter of the fibers in the staple, since the mutual influence of these indicators is at a high level of 0.7.

4. Conclusion

As a result of the research, it was found that the average weight of aboriginal Tuvan coarse-haired goats at the age of 3 years is 39.46 ± 0.86 kg (Cv = 9.2), while the length of the down is 6.35 ± 0.45 cm (Cv = 31.6). The down in the studied goats is shorter than the covering hair and in 35% of the studied animals it exceeds the length of 7 cm. As a result of wool studies using the optical fiber diameter analyzer OFDA 2000, it was found that the proportion of down hair (less than 30 μm) averages 80.21 ± 1.57 % (Cv = 8.8), with a fairly significant difference between the extreme values ranging from 67.52 to 90.84 %. The amount of transitional hairs has critical differences from 2.28 to 19.42 % at Cv = 64.6, while in animals
with a low content of transitional hair in the staple (2.28–4.14%), the peak of the diagram has a value within 15–17 μm, with a correlation coefficient of 0.69. The data obtained allows for the conclusion that, when breeding native Tuvan coarse-wooled goats in order to obtain high-quality down with the smallest fiber diameter, special attention should be paid to the presence of a transitional hair type (30.1–52.5 μm) in addition to the length of the down and its diameter.

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