Behavioral response and genotypical features of grazing sheep in arid zone

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Abstract The issues of natural pastures with different intensities of grazing and behavioral response of fine-wool and hair sheep, genotypic characteristics of sheep by blood groups, variability in antigen frequencies, and their relationship with the adaptability of various sheep breeds to a grazing system are of particular interest. The behavior of sheep in grazing was studied in bands of ewes of hair fat-tailed Kalmyk, Edilbay, and fine-wool Grozny sheep breeds in the agricultural production cooperative Kirovsky, the Republic of Kalmykia. Under extensive grazing, pastures had a high yield of air-dry mass in June at the end of the growing season of steppe plant species, with Gramineae in the associations being more actively grazed than wormwood. Grazing hair sheep of the Kalmyk breed kept pasture 1.4 (P<0.01) times more productive than fine-wool sheep at an average load and 1.3 times at a low load. A favorable forecast for the development of natural pastures in the Republic of Kalmykia was the 1:2 ratio between Asteráceae and Poáceae in the first two or three years of grazing and 1:1 in the ensuing years. The antigen pool of the Grozny breed was significantly different from antigens of hair breed. The antigen structure of the Edilbay breed was similar to the Kalmyk one. The blood group studies showed that the fine-wool and hair breeds had high antigenic similarities in terms of the O antigen, with its frequency of 0.879-0.724. The Cb antigen of the C system was frequent; almost all sheep, regardless of the breed, had the gene in 0.592-0.652 cases.

1. Introduction

The modern vegetation appearance of desert steppes of the South of Russia is determined not only by climatic conditions, but also by anthropogenic impact that has intensified in recent decades [1, 2]. An increase in livestock has decreased the pasture productivity from 6.2 centners of fodder units in 1960 to 1.4 in 2000.

In the Republic of Kalmykia, natural pastures take over 6.0 million hectares and combined with favorable climatic conditions provide sheep with cheap pasture for almost year-round. In 1950-1970, the area of Black Lands was the main grazing territory; it resisted to overgrazing for a long time and preserved biological productivity [3, 4, and 5]. Now it is suffering from desertization.

Depending on natural and climatic factors, breeding conditions affect certain factors fixed in blood and contribute to certain genotypes being preserved in flocks [6, 7, and 8]. Various allele forms of blood groups were examined in terms of their distribution in sheep breeds. The analysis showed genetic diversity of these breeds and similarity induced by external environment.
**The purpose of our research** was to assess natural pastures with different grazing intensity and behavioral responses of sheep of fine-wool and hair breeds, study genotypic characteristics of sheep by blood groups, and determine the variability in antigen frequencies and their relationship with the adaptability of different breeds of sheep to grazing.

2. **Research methods**

The studies were conducted on the territory of the Black Zone in the west of the Caspian lowland. The behavior of grazing sheep was studied in bands of ewes of hair fat-tailed Kalmyk, Edilbay, and fine-wool Grozny sheep breeds in the APC Kirovsky, the Republic of Kalmykia. Sheep were grazing day and night in typical dry steppe pastures.

During the pasture season from April to September, the above-ground phytomass was counted three times, i.e. in the initial (spring) growing season—the first ten days of May; in the end of vegetation of steppe plant species—the second ten days of June; and during the summer dormancy—the third ten days of August.

Vegetation was counted by the method of mowing on sites of 1 m². Mowing was repeated 5 times. The vegetation of each mowing was identified by species and dried to constant weight at 90 °C. On all mowing sites, rags, current litter, and litter were separately taken into account.

Ethological and physiological tests were conducted by the method of selective behavior records. The results were not considerably different from those obtained by continuous observation. With a 15-minute interval, the deviation maximum was 2%.

**Immunogenetic studies.** The hemolysis reaction was performed in blocks or plates of transparent plexiglass with round deep cells. Blood was incubated at a room temperature for 20 minutes; the reaction was seen in a thermostat for 1.5-2.0 hours, and results were recorded in a serological test.

3. **Results**

Biological productivity is an essential functional characteristic of ecosystems. It reflects the properties of the plant community to produce organic matter during photosynthesis.

| Association                  | Live weight | Mortmass | Total phytomass |
|------------------------------|-------------|----------|-----------------|
| Low grazing areas            |             |          |                 |
| Gramineous (Gramineae)       | 8.04±0.46   | 4.30±0.03| 12.34±0.52      |
| Feather grass (Stipa)        | 11.81±0.67  | 6.25±0.05| 17.06±0.56      |
| Mountain brome (Brómus)      | 10.74±0.56  | 4.63±0.05| 14.37±0.63      |
| White wormwood (Artemisialercheana) | 12.47±0.48 | 4.96±0.31| 16.43±0.45      |
| High grazing areas           |             |          |                 |
| Feather grass (Stipa)        | 4.18±0.11   | 4.47±0.02| 8.66±0.48       |
| White wormwood (Artemisialercheana) | 6.15±0.12  | 2.96±0.01| 9.11±0.36       |

At the end of the growing season of steppe plant species, the productivity of steppe phytocenoses varied from 6.18 to 13.74 kg/ha, which made the community similar to the dry and desert steppes with respect to this parameter (table 1). The dead litter covering the ground—the so-called steppe felt—reached up to 3 t/ha in the dry steppe, because the above-ground dry organic matter was produced less intensively.

The productivity of above-ground edible phytomass was directly related to pasture load. At high pasture load, gramineous, white wormwood, and feather grass associations were mainly preserved. At the same time, large areas were occupied with feather grass (Stipacapillata). Its total phytomass contained litter (52.9%) and green mass.
Indigenous sheep of the Kalmyk fat tail breed spare pastures due to the structure peculiarity of their hooves and grazing coarse plants that were poorly eaten by other sheep breeds. An important behavioral feature of the Edilbay breed imported from Kazakhstan is that they trample down pastures less, because they do not move footprints when grazing, unlike Merinos. The Grozny fine-wool sheep had been bred for arid territories of southern Russia and is well adapted to semi-desert and arid areas.

When assessing the pasture productivity, we tracked changes in vegetation due to grazing (table 2). At maximum load, the territories near the camp (100 m) were revealed to have a lower yield than in the most remote pasture areas, regardless of the animal breed.

| Breed    | Distance from livestock camp, m | Load    | Productivity (air-dry phytomass), t/ha |
|----------|---------------------------------|---------|----------------------------------------|
|          |                                 |         | May     | June     | August   |
| Grozny   | 100                             | High    | 1.91±0.02 | 2.62±0.03 | 1.76±0.02 |
|          | 1000                            | Average | 3.22±0.02 | 3.74±0.06 | 2.43±0.04 |
|          | 2000                            | Low     | 6.73±0.10 | 7.27±0.09 | 5.22±0.08 |
|          | 100                             | High    | 2.13±0.03 | 3.13±0.02 | 1.64±0.06 |
| Kalmyk   | 1000                            | Average | 4.44±0.04 | 5.21±0.06 | 3.43±0.05 |
|          | 2000                            | Low     | 9.83±0.11 | 9.95±0.09 | 7.47±0.08 |
|          | 100                             | High    | 1.77±0.01 | 2.53±0.02 | 1.85±0.01 |
| Edilbay  | 1000                            | Average | 3.81±0.07 | 4.35±0.06 | 3.36±0.06 |
|          | 2000                            | Low     | 7.92±0.06 | 9.01±0.07 | 7.32±0.08 |

In areas with an average load, the yield of air-dry phytomass depended on the counting period and was higher 1.7-1.4 (P<0.01) times when grazing the Grozny breed, 2.1-1.7 when grazing the Kalmyk breed, and 2.2-1.7 (P<0.01) when grazing Edilbay breed, compared with high load grazing areas. Grazing hair sheep of the Kalmyk breed kept pasture 1.4 (P<0.01) times more productive than fine-wool sheep at an average load and 1.3 times at a low load.

Under extensive grazing, pastures showed a high yield of air-dry mass in June at the end of the growing season of steppe plant species, while the gramineous constituents of the associations were more actively eaten than wormwood.

Under grazing, the vegetation of pastures changed quickly. Overgrazing inhibited the gramineous constituents and intensified the growth of poorly eaten wormwood in spring and summer. A favorable forecast for the development of natural pastures in the Republic of Kalmykia is the 1:2 ratios between Asterácea and Poáceae in the first two or three years of grazing, and 1:1 ratio in the ensuing years.

To select breeds for the zone of environmental stress, it is necessary to take into account not only the level of adaptation of animals of different genotypes to external conditions, but also the characteristics of the environmental impact on the gene pool [9, 10 and 11]. Therefore, we conducted ethological and physiological tests of the behavior of those sheep breeds in the pasture.

High moving activity of hair sheep was a feature of their behavior. The Kalmyk sheep spent on movement 2.1 times less time and the Edilbaevsky sheep 1.6 times than the Grozny sheep (table 3).

Fine-wool sheep spent 1.7 times less time eating food while moving than the hair Edilbay sheep, and 2.3 times less than the Kalmyk sheep, which is a great advantage at loose grass.

Based on the distribution analysis of the breeds of various allele forms of blood groups, the genetic peculiarity of these breeds was established. Determination of the frequency of certain antigens and their relationship with adaptability to grazing in arid conditions revealed marker antigens (table 4).

The Grozny breed was distinguished by a high concentration of Da and Ma antigens. The Ma antigen frequency of the Grozny breed was higher by 25.5-34.8%. There were found 2.7 times more Da antigen carriers than in the Kalmyk breed and 1.9 times more than in Edilbay breed. The rare Mb was recorded 2.3–1.3 times more often antigen in Grozny sheep than in other breeds compared. At the same time, the Grozny breed had a lower frequency of some antigens in comparison with other breeds analyzed.
Table 3. Sheep’s behavior in pasture.

| Time spent on behavioral acts, % | Breed       |
|---------------------------------|-------------|
|                                 | Grozny      | Kalmyk     | Edilbay    |
| Moving                          | 6.3         | 8.9        | 8.1        |
| Grazing in a group              | 37.2        | 12.7       | 25.0       |
| Grazing in moving               | 30.8        | 69.8       | 52.1       |
| Couching                        | 14.7        | 3.7        | 8.4        |
| Standing                        | 10.5        | 4.5        | 5.8        |
| Feeding lambs                   | 0.3         | 0.3        | 0.4        |
| Other acts                      | 0.2         | 0.1        | 0.2        |

Table 4. Frequency of antigens in ewes of various breeds.

| System | Antigen | Grozny | Kalmyk | Edilbay |
|--------|---------|--------|--------|---------|
| A      | Aa      | 0.196  | 0.812  | 0.413   |
|        | Ab      | 0.175  | 0.376  | 0.112   |
| B      | Bb      | 0.221  | 0.491  | 0.365   |
|        | Bd      | 0.145  | 0.192  | 0.000   |
|        | Be      | 0.000  | 0.020  | 0.110   |
|        | Bg      | 0.010  | 0.040  | 0.020   |
|        | Bi      | 0.000  | 0.000  | 0.125   |
| C      | Ca      | 0.098  | 0.110  | 0.057   |
|        | Cb      | 0.652  | 0.625  | 0.592   |
| D      | Da      | 0.623  | 0.227  | 0.321   |
|        | Ma      | 0.497  | 0.370  | 0.324   |
|        | Mb      | 0.102  | 0.043  | 0.078   |
| O      | O       | 0.724  | 0.879  | 0.861   |
| R      | R       | 0.283  | 0.421  | 0.148   |

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The Kalmyk breed was characterized by a high concentration of antigens Aa, Bb, and Ab. Their Aa antigen frequency was 4.1 times higher than in Grozny sheep and 1.9 times higher than in Edilbay sheep. Carriers of the Ab antigen were detected 2.1 times more often in Kalmyk sheep than in animals of the Grozny breed. The frequency of Bb antigen in the Kalmyk breed was 2.2 times higher than that in the Grozny animals and 1.3 times higher than that in the Edilbay breed. At the same time, the Da and Mb antigens were found in Kalmyk sheep less often than in other analyzed breeds. The Bi antigen was revealed to be absent, like in the Grozny breed.

The genotypic feature of the Edilbay breed was high frequencies of Be and Bi antigens that were absent or very rare in other test breeds. In terms of the Aa frequency, the Edilbay breed exceeded the Grozny breed 2.1 times. With respect to the Da antigen, the Edilbay breed surpassed the Kalmyk breed by 29.2%. At the same time, it is necessary to note the absence of Bd antigen of the B system being frequent in Grozny and Kalmyk breeds.
The O antigen was the most frequent in all sheep breeds. Its frequency in Kalmyk sheep was the highest and made 0.879. Its frequency in other breeds ranged in 0.724-0.861, with the Grozny breed having the lowest value. The Cb antigen of C system was frequent; almost all sheep had the antigen in 0.592-0.652 cases, regardless of breed.

4. Conclusion
Under extensive grazing, pastures showed a high yield of air-dry mass in June during the end of the growing season of steppe plant species, with Gramineae in the associations being more actively eaten than wormwood. Grazing hair sheep of the Kalmyk breed kept pasture 1.4 (P<0.01) times more productive than fine-wool sheep at an average load and 1.3 times at a low load. A favorable forecast for the development of natural pastures in the Republic of Kalmykia is the 1:2 ratio between Asterácea and Poáceae in the first two or three years of grazing and 1: in the ensuing years.

The antigen pool of the Grozny breed was significantly different from the antigen pool of hair breed. The antigenic structure of the Edilbay breed was similar to the Kalmyk one. The blood group studies showed that the fine-wool and hair breeds had high antigenic similarities in terms of the O antigen with a frequency of 0.879-0.724. The Cb antigen of the C system was frequent; almost all sheep, regardless of the breed, had the gene in 0.592-0.652 cases.

References
[1] Mysik A T, Efendiev B Sh and Ulimbashev M B 2017 Natural feed resources of different ecological zones of the Central Ciscaucasia Zootechniya 6 21-5
[2] Gorlov I F., Fedotova G V, Slozhenkina M I, Zlobina E Y and Mosolova D A 2019 Nutritional value of beef from steers grown on natural pastures of arid territories International Journal of Innovative Technology and Exploring Engineering 9(1) 4545-49
[3] Afanasyeva A I Simonova I V and Katamanov S G 2009 Protein composition of blood serum of sheep of different genotypes Bulletin of Altai State Agricultural University 5 43-6
[4] Trofimov I A 1995 Natural fodder lands of the Black Lands (Moscow-Elista: Korkis) pp 53-83
[5] Chamurliey N G, Chapurkina O V and Filatov A S 2013 Feeding and fattening of young sheep of the Volgograd breed at different levels of protein Izvestiya of the Low Volga Agro-University Complex: science and higher professional education 1(29) 127-31
[6] Omarov R, Gorlov I, Slozhenkina M, Mosolova N and Shlykov S 2019 Development of a technology for the directed modification of fatty acid composition of beef in grass-fed feeding: International Journal of Recent Technology and Engineering 8(4) 5969
[7] Dvalishvili V G, Magomadov T A and Gorshkov M A 2007 The use of feed by rams of different origin Sheep, goats, wool production 2 32-9
[8] Aliev A A and Olimov A A 2000 Lipid metabolism and productivity of fat tail and fine-wool sheep Sheep, wool production 2 57-63
[9] Kvitko Yu 2011 Feed for young sheep of different origin and productivity Chief livestock specialist 6 40-2
[10] Kayumov F G, Gerasimov N P, Tretyakova R F, Sleptsov I I, Iлина Е N and Moiseikina L G 2018 Environment and genotype effect on morphological and biochemical composition of blood in kalmyk cattle Research journal of pharmaceutical, biological and chemical sciences 9(5) 175-81
[11] Bogolyubova N V, Romanov V N, Devyatkin V A, Gusev I V, Bagirov V A and Zinovieva N A 2016 Biological parameters for digestive and metabolic processes in interspecies hybrids of domestic sheep (Ovis aries) and argali (Ovis ammon polii) Agricultural biology 4(51) 500-8