



Reconnaissance Experience in Stimulating Artificial Shedding of Down in 2 Goat Genotypes Based on the Chemical Preparation Cyclophosphamide

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Abstract | The purpose of the reconnaissance experiment was a series of preliminary studies aimed at breeding aspects of increasing the down output of goats of local breeds and reducing the cost of manual labor in the technology for obtaining down. The research was carried out at the "Aiganym" farm of the Zhambyl district on one-year-old goats of the Kazakh coarse-haired and Gorno-Altai downy breeds as well as their crossbreeds. Animal groups were formed according to the principle of analogue groups, taking into account age and live weight. Animals downy breed were more than 2.5 times higher than the animals of the local Kazakh coarse-haired breed in terms of down output. Crossbred animals obtained by crossing animals of the Gorno-Altai downy and Kazakh coarse-haired breeds occupied an intermediate position between the original breeds in terms of most down indicators. For 5 days, the goats of the experimental groups underwent intramuscular injection of the cyclophosphamide drug at a dose of 7 ml/kg of body weight. The results showed one-year-old goats of the Kazakh coarse-haired and Gorno-Altai downy breeds subjected to an intramuscular injection did not show a molt of down, but the output during their brushing was, respectively, 14.3 and 7.8% higher than that of the peers in control groups due to better separation of down. The down output in experimental animals partially increased and its technological qualities improved – the thickness of the down fiber was 0.3 and 0.5 microns thinner in experimental animals, and, as a result, had a higher comfort factor.

Keywords | Breed, Crossbreeding, Crossbreeds, Comb, Brushing, Technological characteristics of down

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INTRODUCTION

Goat breeding is a traditional branch of animal husbandry in Kazakhstan, while the down direction has great development prospects. Kazakh coarse-haired (KC) goats are the main producer of goat down in Kazakhstan. The down of animals of this breed meets the requirements of Kashmir down, which is confirmed by the research of

the Institute of Sheep Breeding, together with scientists from Great Britain and the USA (Iñiguez et al., 2014). Their results made it possible to raise prices for down in the composition of sheared wool in the domestic market up to 3000 tenge per kg, thereby stimulating an increase in demand in the domestic market for their sheared coarse wool. Kazakhstan does not produce down from goats of coarse breeds, and this valuable raw material is sold in a

mixture with coarse wool, i.e., in the form of shorn wool (Dzhurinskaya et al., 2020). This approach reduces the quality of raw materials and increases the cost of preparing them for further technological processing (Dzhurinskaya et al., 2021; Mutalov et al., 2020). Goat down is a valuable raw material that is used in the textile industry for the production of light fabrics and fashion clothing. These products are in great demand and are highly valued in the world market (Hunter, 2020). The main producers of Kashmir down in the world are China, Mongolia and the countries of the Middle East (Van der Westhuysen, 2005). In the Republic, the main population of goats is represented by Kazakh coarse-haired goats of the combined direction, goats of the Soviet wool breed and, in part, crossbred dairy and downy goats. As indicated in the research by Nuraliev (2011), the production of down from coarse-breed goats in Kazakhstan and the republics of Central Asia was considered inefficient due to the low level of down output, which is a deterrent to the rapid development of the industry. In addition, most of the livestock is kept in a personal farmstead and is used mainly for obtaining milk and meat, while no attention is paid to other productivity areas. These circumstances complicate the selection improvement of the population of downy goats in Kazakhstan. This issue may be solved by ensuring the selection of Kazakh coarse-haired breed goats on the basis of genetic improvement, as indicated in the studies of a number of authors (Selionova et al., 2021; Almeev et al., 2019; Petrov, 2019; Petrov, 2019a). Partial interbreeding remains the main method of improving the quantitative and qualitative characteristics of down in goats. Similar work was carried out in Kyrgyzstan. So, in the research by Almeev et al. (2018), the Kyrgyz downy goat was bred by crossing native goats with the Don downy breed. The down output of such goats has increased to 300–400 g.

An equally relevant issue is the development of the practice of combing commercial down. It is obtained by combing animals during the shedding period. Shedding in goats begins with downy and transitional hairs, followed by the outer hairs. This feature makes it possible to obtain high-quality downy raw materials during combing in the early stages of shedding. Since the process of shedding is caused by a large number of factors, even in animals of the same breed, it is rather extended in time (Nocelli et al., 2020). To synchronize this process in a large population of animals within a time frame and reduce the cost of manual labor when combing them, shedding in animals is artificially stimulated. As such stimulants, chemicals are used that can cause the shedding process. Preparations based on cyclophosphamide (Chen et al., 2018; Chen et al., 2019) and the non-protein amino acid mimosine or leucenol (Luo et al., 2000; Reis et al., 1999) are most studied and often used to stimulate artificial shedding.

The above arguments point to a number of problematic issues in the development of the down goat industry in Kazakhstan. Even the increase in the number of goats, which has been observed in recent years in Kazakhstan, will not be able to solve the issues of low-down output of local goats and the high cost of down due to the high costs of manual labor. Therefore, in the context of the development of downy goat breeding in Kazakhstan, the current focus of modern scientific research is not only to improve the existing breeds in terms of down output, but also to develop and implement modern technologies for obtaining down in agricultural and other enterprises involved in processing wool and down products. This technology will increase the profitability of the industry and increase the attractiveness of this type of business in the country.

The aim of this study was to conduct preliminary research on two key areas related to the development of downy goat breeding in Kazakhstan. Specifically, the study focused on breeding aspects that could increase the down output of local goat breeds and reduce the cost of manual labor in the technology for obtaining down.

LITERATURE REVIEW

Obtaining down from goats is a rather long and labour-intensive process. This is due to the fact that manual combing remains the main method of obtaining it (Vankov and Kozlovtssev, 2014). The paper by Gerasimenko and Vankov (2014) indicates that the depth of the hair roots and down in different parts of the body is varied, and different efforts will be required when combing out the down. Maximum effort is needed when combing out the down on the back, sacrum and shoulder blade of the animal. This limits the widespread use of the mechanical combing method.

Labor productivity with the manual method is very low and amounts to about 8–10 goats per day (Ansari-Renani et al., 2013; Yang et al., 2022; Li et al., 2022; Han et al., 2022). It is possible to reduce the cost of manual labor by using artificial shedding methods. Similar approaches have been carried out on laboratory animals. The following were tested for this purpose: the cyclophosphamide anti-tumor drug, the mimosine non-protein amino acid, and some steroid hormones. The results of B.A. Panaretto et al. (1978) showed that the first two drugs caused complete hair loss in mice, while steroid hormones only slightly inhibited their growth. These results were confirmed in subsequent studies by these authors on sheep. After that, studies were carried out only on productive animals. Reynolds et al. (1972) determined the dose of cyclophosphamide to induce shedding in sheep. The use of 16, 20 and 30 mg of the drug showed that increasing the dose contributed to an increase in the area of wool loss in sheep and the duration of the effect. The studies of Yegana et al. (1983) indicate

that a single intravenous injection of 1-1.5 g of cyclophosphamide caused chemical shedding only in some animals. But the main thing in these experiments was the absence of an adverse effect of the drug in small doses both on the body of the animal and on the body of the fetus. Also, the absence of an effect on the body was noted with intramuscular administration of drugs and in studies by other authors (Jackson et al., 1975; Han et al., 2022).

The positive results of shedding stimulation in sheep allowed them to be extrapolated to goats. An analysis of publications on the problem of chemically stimulated shedding in downy goats indicates its active use in recent years. Thus, the use of mimosine for chemical shedding in goats was considered in the papers of Luo et al. (2000) and Reis et al. (1999). Luo et al. (2000) indicates that twofold intravenous administration of mimosin at a dose of 120 mg/kg of live weight caused shedding in all experimental animals. The maximum effect was observed on days 12-16. Similar research results were obtained in the experiments of Reis et al. (1999) with intravenous administration of the drug. Oral administration of mimosin preparations did not cause down loss either on 7th or 31st days after feeding it at a dose of 400 and 600 mg/kg of body weight. This could be the result of the action of a specific enzyme that is able to catalyze mimosin to pyruvate and ammonia (Negi et al., 2013). This enzyme is secreted by a number of microorganisms that live in the rumen of the animal.

Cyclophosphamide has a more predictable effect on the body of goats. Chen et al. (2018; 2019) determined the optimal dose to stimulate shedding in goats, which was 20 mg/kg of live weight for 10 days. Down loss was observed as early as 10 days after the start of the drug administration. Of the side effects on the body of animals, minor changes in the blood system are noted – a decrease in the number of erythrocytes and hemoglobin, which quickly disappears. In addition, cyclophosphamide caused the shedding effect regardless of the application method, whether intravenously, intramuscularly and orally, with a slight difference in the time of manifestation. The possibility of a simpler introduction of the drug into the body of the animal and the predictable effect of stimulating shedding determined the use of cyclophosphamide in this experiment.

MATERIALS AND METHODS

The studies were carried out on clinically healthy animals that were kept in the “Aiganym” farm (Kazbek Bi station, Temirzhol rural district) of the Zhambyl district of the Almaty region. In the experiment, one-year-old goats of the Kazakh coarse-haired and Gorno-Altai downy (GA) breeds and their crossbreeds were used. All animals were kept and fed under the same conditions. The maternal live-

stock of the Gorno-Altai downy breed was brought from Russia to the Pavlodar region, and later became widespread in “Aksunkar 2017” LLP (limited liability partnership), Zhambyl district, Almaty region as well as in adjacent agricultural enterprises. The exploratory study involved investigating the impact of a cyclophosphamide-based preparation on shedding in animals of varying genotypes and assessing the effect of different combs on the quantity and quality of the obtained down.

The experimental group of animals consisted of 3 goats of the Kazakh coarse-haired and 3 Gorno-Altai breeds. Three groups were formed as control, which included 5 goats of the Kazakh coarse-haired breed, 10 peers of the Gorno-Altai breed and 10 hybrid animals obtained by crossing animals of the above breeds with different proportions of blood of the improving breed. Animal groups were formed according to the principle of analogue groups, taking into account age and live weight. In an experiment to study the effect of the cyclophosphamide drug on the course of shedding, the drug was administered in experimental animals at a dose of 7 ml/kg of body weight for 5 days. Since the animals of the studied breeds have slightly different time periods of shedding, the drugs were administered at the optimal periods for this. The drug was injected in goats of the Kazakh coarse-haired breed from March 24 to 28, while animals of the Gorno-Altai downy breed received it 10 days earlier – from March 10 to 14. Accordingly, the combing of down raw materials was carried out at the optimal shedding time for each of the breeds.

In the second half of the experiment, tools of world production and a Kazakh improved version of the comb were used to study the effect of combs of various shapes for combing out down on the quantity and quality of down products from animals. The design differences in the combs lied in the shape of the teeth. The improved comb had a traditional shape for Kazakhstan with teeth bent in the form of a half ring. The world-made comb had straight teeth that were bent 90 degrees. The combing of down was carried out by experienced down combers. Animals were fixed in the “lying” position on tables with their legs fixed.

The resulting down from each experimental animal was individually weighed on a laboratory HVLA 2 accuracy class balance weights, and its quality was determined according to GOST 2260-2006 “Unwashed goat down classified. Specifications” (2006). For this, an MBI microscope with a microscopic ruler and an ocular micrometer was used to determine the fineness of down fibers, while special rulers were used for measuring the natural and true length of down fibers. The obtained research results were statistically processed using the Excel analysis package included in the Microsoft Office software package.

Table 1: Down output of goats of the Kazakh coarse-haired and Gorno-Altai downy breed and its hybrids during natural (control) and stimulated shedding (experiment).

Indicator	Experimental group		Control group		
	KC	GA	KC	GA	Crossbred animals
Number of goats, animals	3	3	5	10	10
Duration of combing, min.	25±3.3	43±5.2	28±3.5	48±6.2	34±4.7
Mass of commercial down g/head.	92±9.2	228±12.3	84±10.3	215±9.7	148±11.3
The content of down in the coat before combing, %:	35	55	33	54	45
after combing	7.5	5.6	9.2	8.3	9.5

Table 2: The quality of the down of one-year-old goats of the Kazakh coarse-haired breed and Gorno-Altai downy breed during natural (control) and stimulated shedding of down (experiment)

Indicator	Experimental group		Control group		
	KC	GA	KC	GA	Crossbred animals
Down yield in pure fiber, %	90.0±3.8	93.7±5.4	88.6±7.4	91.2±8.8	86.9±7.3
Residual content in combed down:					
skeletal fibers, %	8.5±0.8	5.2±0.5	9.6±0.5	7.4±0.4	10.8±0.9
mechanical and organic litter, %	1.5±0.1	1.1±0.1	1.8±0.1	1.4±0.1	2.3±0.2
Fineness	17.1±0.9	19.4±1.1	17.4±0.7	19.9±0.8	18.4±0.7
Variation factor, %	20.3	21.9	19.1	20.0	21.9
Comfort factor (fibers up to 30 µm)	100.0	99.9	99.7	98.0	99.8
Crimp of fibers	36.0	40.7	48.1	34.0	43.0

RESULTS

The down output of animals of the Kazakh coarse-haired and Gorno-Altai breeds during natural and artificially stimulated shedding was studied taking into account its natural terms for each group – in early April in goats of the Gorno-Altai breed and its hybrids, and in the second half of the same month in animals of the Kazakh coarse-haired breed. The results of down pile and its quantitative characteristics are presented in Table 1.

The research results revealed a significant difference between animals of different genotypes in terms of the mass of the down obtained. Thus, the down yield of goats of the specialized Gorno-Altai downy breed was more than 2.5 times higher than that of the local Kazakh coarse-haired breed. Accordingly, the time for combing out the down of one goat was longer in animals of a specialized breed. The difference between the breeds was 18-20 minutes. The reason for the longer combing is the high content of down fibers in the undercoat of specialized breeds, which are combed out with the use of great amount of manual labor due to the regular removal of down from the combs. Also, the level of down combing was higher in animals of downy breed – 85% vs. 72% in coarse-breed goats.

Higher combing results were found in the animals of the experimental group – 89% and 79%, which, for sure, was

the result of the action of a chemical preparation based on cyclophosphamide. Facilitating the separation of down by injecting a chemical preparation into the animals of the experimental group contributed to a slight reduction in the combing time of the experimental animals by 3-5 minutes. These results were not significant in comparison with the control and fell within the statistical error. The best separation of down in the goats of the experimental group provided a slight increase in the yield of combed raw materials – 92 g for coarse-breed and 228 g for downy goats, against 84 and 215 g for the control ones. The difference was 8 and 13 g, or 9.5 and 6.1%, respectively.

Crossbred animals occupied an intermediate position in terms of the output of marketable down between animals of the original breeds. Accordingly, the technological indicators of the down output of crossbred animals, namely the duration of combing and the residual amount of down, occupied an intermediate position between the original breeds. Quantitative indicators of down output of goats under the conditions of an experimental farm were largely dependent on genetic factors, the breed of animals, while artificial stimulation of shedding practically had an effect. The next stage of the paper was the analysis of the qualitative indicators of the obtained down raw materials in control animals. The results are shown in Table 2.

Table 3: Some indicators of the economic efficiency of down production with artificially stimulated shedding in goats of different genotypes

Indicator	Experimental group		Control group		
	KC	GA	KC	GA	Crossbred animals
Mass of commercial down, g/animal.	92±9.2	228±12.3	84±10.3	215±9.7	148±11.3
Labor productivity of the comber, animals/h.	2.4	1.4	2.1	1.3	1.8
Labor costs, tenge	4400	1760	4800	1880	2720
Cost of purchasing the drug per animal, tenge	8000	8000	0	0	0
Cost of 1 kg of down, tenge	87200	35200	4800	1880	2720

The down output in animals of a specialized downy breed was predicted to be higher than that in native animals of the Kazakh coarse-haired breed and crossbred livestock. The outer fibers in the coat of goats of the Gorno-Altai breed have, in comparison with down fibers, a shorter length, which contributes to a better and faster separation of the down in the process of manual combing, thereby ensuring an increase in the yield of products in pure fiber. The output of combed down, as the main indicator of down productivity, was practically the same in control animals, regardless of breed. In purebred Gorno-Altai goats, depending on the methods of shedding stimulation, 91.2-93.7%, versus 88.6-90.2% in Kazakh coarse-haired breed animals. Crossbred animals in terms of the mass of marketable down did not fit into the intermediate indicators between the original breeds. The percentage of skeletal fibers turned out to be even higher than that in purebred Kazakh coarse-haired breed goats. Unfortunately, due to the impossibility of a clear separation of the genotypes of the crossbred animals that participated in the experiment, the study of this phenomenon will be continued in future research.

Animals of the experimental groups, regardless of genotype, had a greater yield of down in pure form compared to control animals. The increase in the specific gravity of the combed out down obtained from experimental animals was associated with a lower content of undesirable guard fibers, with a decrease in their number by 2.5-3.2% in combed raw materials. As a result, the residual content of outer fibers in the marketable down of the Gorny Altai goats meets the requirements of the CIS (Commonwealth of Independent States) standard (GOST 2260-2006..., 2006) for combed down of the 1st class, while in coarse-breed goats only in terms of down from artificially stimulated shedding (8.8%), with an excess of this standard in goats from in the period of natural shedding – 11.4%.

Presumably, one of the factors for increasing the yield of pure down in experimental animals was associated with the action of cyclophosphamide on hair follicles, which contributed to easier combing of fluff, and, accordingly, an increase in its percentage in raw materials. Possibly, the

relatively lower fineness of fibers by 1.8 and 2.6% in Kazakh coarse-haired breed and Gorno-Altai goats was also associated with this. It should be noted that the technological characteristics of down in experimental animals were better than those in the control groups of goats. The down fiber thickness was 0.3 and 0.5 μm thinner in the experimental animals and, as a result, it had a higher comfort factor score. Therefore, the stimulation of artificial shedding allows not only to partially increase the yield of down from animals, regardless of the breed factor, but also to improve its technological qualities. An equally important factor in the production of goat down is its economic performance. Profit determines the feasibility of doing business, regardless of industry or priority. Therefore, the development of downy goat breeding in Kazakhstan requires proven methods that guarantee high profitability. In their research, the authors identified economic indicators as a separate segment (Table 3).

In Kazakhstan, three varieties of cyclophosphamide preparations are sold in pharmacies in the form of a powder for injection – Endoxan, Cyclophosphamide Kelun, Cyclophosphamide. Therefore, the administration of the drug to experimental animals was carried out by intramuscular injection. The average price of drugs, regardless of the manufacturer, amounted to 1500 tenge per 200 mg, plus the cost of novocaine for its dilution, which amounted to 100 tenge per 5 ml. Using the method of mathematical addition, it is easy to determine that the cost of purchasing the drug for its injection to experimental one-year-old goat (weighing 30 kg) at the recommended dose (20 mg/kg body weight) for 10 days would amount 46000 tenge/head, or about USD 100 at the prevailing exchange rate of the national currency against the US dollar. But, since young animals took part in the experiment, it was decided to reduce the dose of the chemical preparation to 7 mg/kg of live weight and the duration of its use to 5 days. This is almost 3 times lower dose of the drug in comparison with the recommended regimen for the use of such substances (Chen et al., 2019). As a result, the cost of cyclophosphamide preparations for the experiment amounted to 8000 tenge per 1 animal of the experimental group.

The results of the reconnaissance experiment show that the intended purpose of using a chemical preparation based on cyclophosphamide, which is to increase the productivity of down combers, has not been achieved practically. The low productivity of down and the high costs of manual labor to achieve it resulted in high labor costs for down combers in animals of the local Kazakh coarse-haired breed. Although there was a slight increase in the number of combed one-year-old goats weighing 30 kg per hour by 0.1-0.3 units, this is not enough to recommend the use of the drug for this category of animals. During the study, the cost of the obtained down in the experimental groups increased almost 20 times compared to control animals, regardless of their genotype, due to the low-down output of one-year-old goats. The effectiveness of the scheme for using drugs to stimulate artificial shedding in adult animals, taking into account their higher down output, should be increased. The authors will conduct further scientific research on this subject.

The main technological method of obtaining down from goats is its manual combing. Combs of various shapes are used for this purpose. In this experiment, world-produced combs and their improved Kazakh version were tested. Technological aspects of the use of combs were evaluated by the efficiency of combing out down in animals of experimental breeds. The foreign version of the comb, in view of its design features – the placement of 3 thin teeth for each centimeter of its length, turned out to be more effective for animals of the Kazakh coarse-haired breed, which have a relatively short coat. When using this type of comb for specialized downy breeds, such as the Gorno-Altai goats, the straight-shaped teeth, which are bent at a 90-degree angle and are 40mm in length, become filled with combed down within 1-2 combs and need to be constantly cleared. This reduces the productivity of down combers. The improved Kazakh version of the comb is structurally distinguished by thicker teeth (made of wire with a diameter of 2-3 mm) and their distribution of one tooth per centimeter of the length of the comb. At the same time, the teeth are 100-150 mm long with rounded edges. This design makes it easier for the down to move along the comb. The greater distance between the teeth allows, regardless of the density of the downy undercoat, to comb out the down even with repeated combing. This comb design does not require frequent stops to remove combed down and increases productivity. The improved Kazakh version of the comb turned out to be more acceptable for animals of specialized downy breeds.

DISCUSSION

Goat breeding, as a branch of agriculture, is rapidly developing in the Republic of Kazakhstan. As of January 1,

2022, there is an increase in the population of sheep and goats by 4.1%, up to 20,877 thousand animals in all categories of agricultural producers. According to the Bureau of Statistics, farm animals are mainly being kept in households – 52% of sheep and goats (*In Kazakhstan, the number of cattle ...*, 2022). Basically, goats in the Republic are used for meat, while other areas of productivity – dairy and downy – are not a priority (Petrov, 2019). But in recent years, taking into account the rise in prices for downy raw materials and the increase in exports to China, more and more farms are switching to breeding downy goats. This is confirmed by the materials of the Bureau of Statistics of the Republic, which indicate an increase of 2.5% in the amount of received and sold wool in 2021 compared to 2020 (*In Kazakhstan, the number of cattle ...*, 2022). The availability of large areas in hard-to-reach mountainous (7.2 million ha) and rocky (18.2 million ha) regions of Kazakhstan that can be used for organizing pastures also contributes to reducing the cost of raising and keeping animals (*Goat breeding in Kazakhstan*, 2020).

During the reconnaissance experience, the authors conducted a series of preliminary studies to determine the directions for further scientific research in two key areas related to the development of downy goat breeding in Kazakhstan. These areas are breeding aspects to increase the down output of local goat breeds and reducing the cost of manual labor in the technology for obtaining down. The main breeding approach that will accelerate the development of downy goat breeding in the Republic and bring it to a new level is the genetic improvement of the local breed of goats – the Kazakh coarse-haired breed. There are a very large number of specialized downy breeds of goats in the world that could be used in the absorption crossbreeding program, but in their research, the authors settled on animals of the Gorno-Altai downy breed. This choice was due to the fact that goats of this breed have been acclimatizing and adapting to the conditions of the semi-desert zone of the south-east of the Republic for a long period of time (several generations). This made it possible to neutralize most of the paratypical factors when comparing animals of experimental breeds (Getachew et al., 2022).

In these studies, 2.5 times more down was obtained from one-year-old goats of a specialized downy breed than from local coarse-breed counterparts. In almost all quantitative and qualitative indicators, the down from the Gorno-Altai goats was better than that of native animals. Such performance indicators make it possible to recommend the use of animals of this breed as a candidate for improving local Kazakh goats. Crossbred animals obtained by crossbreeding animals of the Gorno-Altai downy and Kazakh coarse-haired breeds occupied an intermediate position between the original breeds in terms of most indicators

of down. Similar results were obtained during the selection improvement of local breeds by absorption crossing with goats of the Orenburg downy breed in Kyrgyzstan (Almeev et al., 2018). Crossbreeds of the first generation had higher rates of down yield compared to local animals, and further “addition of blood” of the improving breed contributed to a further increase in the quantitative and qualitative indicators of down.

The only indicator that exceeded the indicators of the parent breeds in the crossbreeds of the Kazakh coarse-haired and Gorno-Altai breeds was the content of the outer fibers in the combed down raw materials. But, since there was no breeding record of goats on the farm, it was not possible to analyze the genealogical origin of crossbred animals and their pedigree (blood relation with the improving breed). Perhaps this was the reason for the increase in the number of core fibers in down raw materials. Therefore, more detailed studies in this direction will be the goal of future research by the authors. Based on the technological aspects of improving the down output of goats, an analysis of two factors was carried out – the use of artificially stimulated shedding in animals and the use of combs of different designs to increase the productivity of down combers.

The main idea of using a chemical preparation to induce artificial shedding was to increase the productivity of down combers by reducing the holding capacity of down fibers in hair follicles. The cost of an artificial shedding agent in Kazakhstan amounts to about USD 100 per animal weighing 30 kg, according to the traditional scheme for the use of the drug indicated in the work of Chen et al. (2018; 2019). The high cost of the drug in the prime cost of down, obtained by artificially induced shedding, does not pay off even when the down is sold at the highest prices on the world market – USD 100 for Kashmir and USD 60 for Kashgor per 1 kg. These prices do not even cover the cash investments for the purchase of the drug itself. To reduce the cost of stimulating shedding, the administration of the drug in the experiment was carried out for 5 days at a dose of 7 mg/kg of live weight. This was due to the fact that the experiment was carried out on young animals, and this could prevent the possible toxic effect of the chemical on their body. As a result of using such a small dose during the experiment, the cost of the drug amounted to only 8000 tenge (USD 18) per experimental animal.

A low dose of the drug and its use for a short period made it possible to reduce the time for combing out fluff in one experimental animal by only 3–5 minutes, which practically did not affect the productivity of the combers. Insignificant 5–10% increase in the down output of animals in the experimental groups in comparison with the control ones, instead of reducing the cost of manual labor of specialists,

led to an increase in the cost of the raw materials obtained. In this study, the cost of combing 1 kg of down due to its low yield amounted 87,200 tenge (about USD 190) for coarse-breed goats and 35200 tenge (about USD 76) for Gorno-Altai goats, against 4800 (USD 10) and 1880 (USD 4) tenge in peers who have not been treated with a chemical preparation. The low efficacy of the drugs may have been due to insufficient dose, therefore, in the future, it is planned to conduct a study on full-aged animals using a dose of 20 mg/kg live weight, as recommended by Chen et al. (2018; 2019).

Another direction of research in reducing the cost of manual labor in the technological process when obtaining down was testing combs of foreign origin and a version improved by the authors. Preliminary results of such experiments showed that foreign-made combs turned out to be more effective for combing out down in animals of the Kazakh coarse-haired breed, while in case of animals of a specialized breed, its use only reduced the efficiency of specialists due to the constant clogging of the teeth with down. Such problems were not observed when using Kazakh combs. For a constructive improvement of the foreign version of the comb, a metal plate was passed along the teeth, the advancement of which ensures a change in the distance between the teeth. The combing of the down begins when the web is located within the handle of the comb, and its gradual advancement is carried out along the combing of the down, which excludes the use of the traditional version of the Kazakh comb. Due to such a constructive improvement, it was possible to partially increase labor productivity. Since the experience of the authors at this stage was of an evaluative nature, only combs of different designs were tested for the effectiveness of combing out down in animals of different genotypes. In further experiments, it is planned to conduct additional studies on the effect of different combs on the down combing time, their clogging and additional time for their cleaning during operation.

CONCLUSIONS

Based on the results obtained during the reconnaissance experiment, preliminary conclusions were drawn and a number of directions for subsequent scientific research were developed on their basis. Genetic improvement of the local Kazakh coarse-haired breed by animals of the Gorno-Altai downy breed contributed to the improvement of the quantitative and qualitative characteristics of down raw materials in crossbred animals. An intermediate type of heritability of traits of down output was noted in the process of interbreeding. The next stage of work in this direction will be the study of the effect of “blood relation” with the improving breed on the down output of crossbreeds and the determination of final genotypes for breed-

ing “inter se”. The use of cyclophosphamide preparations makes it possible to partially increase the yield of down from animals, regardless of the breed factor, as well as to improve its technological quality by reducing the fineness of down fibers and increasing the comfort factor. Therefore, authors consider research in this direction to be promising and worthy of further study.

The use of a chemical preparation based on cyclophosphamide to stimulate artificial shedding in experimental goats at a low dose of 7 mg/kg of live weight does not have the prospect of practical application due to its low efficiency both in the yield of down and in terms of manual labor costs when combing it. Authors see a promising direction for further work in this segment in the search for an effective dose of the preparation and a scheme for its use, which could reduce the cost of manual labor in obtaining down and, at the same time, did not affect its profitability. It is advisable to use combs for different breeds of goats depending on their design. For coarse breeds, it is better to use combs with closely spaced teeth, while combs with rare and rounded teeth are better for specialized downy breeds that have a fairly thick undercoat. Future technological research will focus on the effect of combs of different designs on the degree and speed of down combing in goats.

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CONFLICT OF INTEREST

The authors have declared no conflict of interest.

NOVELTY STATEMENT

The development of modern down production technology and its implementation in agricultural enterprises will increase the profitability of the industry. It has been established that the use of cyclophosphamide preparations allows to partially increase the yield of down from animals, regardless of the breed factor, and also to improve its technological quality. The improved Kazakh version of the comb turned out to be more acceptable for animals of specialized down breeds. The design of the comb does not require frequent stops to remove combed fluff and increases labor productivity.

IJ and TK - conceived and planned the experiments. KI and BN material sample collection and analysis; TK, KI and BN - wrote the draft; IJ - final revision.

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