Index selection of Kazakh karakul sur-type sheep with platinum shades

MUKHIT DYUSEGALIYEV, UTENBERGEN BISENOV,
AYMAN NURGALIYEVA, ELMIRA ADIETOVA

Department of Biology and Agricultural Disciplines, Atyrau State University.
H. Dosmukhamedov Ave., Student 212, Atyrau, Kazakhstan

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Summary

Karakul sheep farming is one of the effective subsectors of animal breeding in the south-western region of Kazakhstan. Sheep coloring is a result of genetic factors. Breeding can provide farmers with offspring of the desired color through the selection of parental couples. This research introduces an index method for breeding sur-type sheep with the proportion of underfur fibers under 25%. Such a proportion of underfur fibers provides a 15.25% deeper color within the breed at the 25.3% higher chance of getting platinum shades. Platinum coloring in sheep makes them less piebald. The inheritance index is quite stable and is within 55.66-65.66%. In the breeding flock, the initial proportion of sur-type lambs which could be used in coat making (elite class) was up to 8.72%. The analysis of platinum color heritability by Kazakh sur-type karakul sheep shows that this color is inherited as a dominant one in the line breeding. The share of sur-type sheep with platinum shades was between 85.85% and 87.27%. The difference in the inherited trait between the groups of sheep selected according to the proportion of underfur fibers was insignificant, 0.99-1.42% ($P > 0.05$). The stabilizing selection introduced into the theory of line breeding of Kazakh sur-type sheep allowed optimizing the variability of selected features to the level of desired parameters. The authors have proposed the index selection method for sur-type sheep breeding that can be applied to improve the Atyrau sheep flock, to increase their genetic potential, and to apply various line breeding levels to accelerate the breeding process. The originally designed method for improving breeding indexes will be useful when setting optimal breeding goals (fur color and quality) and assessing genetic parameters of a certain sheep flock. The study was approved by the Ethics Committee attached to the Far Eastern State Agrarian University (Protocol No. 5 of 25 May 2010).

Keywords: breeding, index selection method, fibers, selection

Karakul sheep farming is a result of organizational and breeding activities carried out to develop arid and semiarid areas (1). Other livestock industries are no match for karakul sheep farming when it comes to product diversity (11). Karakul sheep have high endurance and are well adapted to grazing in desert and semi-desert conditions. Adult animals have an elongated head, a Roman type nose, and long hanging ears. The body is big enough, with strong bones and relatively high limbs. A fat-rumped wide tail ends with an S-shaped finial. The uterus of karakul sheep weighs from 45 to 50 kg. Males generally have well-developed horns, while the females are usually hornless (13).

Karakuls can have black, gray, sur (golden brown), white, pink and colored coats (12, 15, 16). The sur-

type color is the most original and elegant color that a karakul can have. The sur-colored two- to three-day-old lambs have unevenly pigmented curls. They have a dark base, which may be black, reddish brown and tan, with silvery white or golden yellow top fur (15, 16).

Sheep coloring is a result of genetic factors. Breeding can provide farmers with offspring of a desired color through the selection of parental couples.

The direction of this research was selected with regard to the following prevailing problems that exist in the karakul sheep farming of Kazakhstan. These problems include:

- a high demand for karakul pelts with original colors on foreign and domestic fur markets;

- extremely low adaptation of Surkhandarya sur-type sheep from Uzbekistan to the conditions of Western Kazakhstan;

- lack of breeding achievements in this field (14).

The issue in current line breeding is the further improvement of selection methods and techniques to enhance breeding and qualities of the original flock.

What is currently important about line breeding is that methods and techniques of selection must be improved so that they can enhance breeding and fixation of the main selected traits of the original flock. The range of traits includes color brightness and evenness over the entire surface of pelts; long and medium, narrow semicircular curls; strong and normal silkiness and luster of wool, and other economically useful fur quality indices (1). If sur-type sheep are bred without any coloring, then the resulting sheep will be with poor-quality fur not vivid in color. Traditional methods for assessing karakul lamb fur coloration imply visual assessment of their coat pigmentation. These methods provide subjective results in large-scale selection (17). Hence there is an urgent need to improve selection by using modern methods for estimating the value of breeding. These modern methods include calculation of complex selection indices. In this context, this research is targeted at developing a selection index geared towards underfur fibers. The fur-corrected selection index will allow breeding karakul sur-type sheep with platinum shades.

The purpose of this research is to develop a selection index to select sheep with platinum shades of fur for line breeding and to study the platinum color heritability in Kazakh sur sheep.

Material and methods

The Ethics Committee attached to the Far Eastern State Agrarian University (Protocol No. 5 of 25 May 2010) approved the study.

The selection program to create a flock of Kazakh karakul sheep of original colors was performed in two stages:

Stage I – a selection index is introduced to enhance the genetic potential of sur-type sheep.

Stage II – color inheritance across the flock is studied; line breeding of varying degrees is used to speed up the breeding process.

Study areas. The study was carried out in a basic farm enterprise of the Western Kazakhstan. The research period was from 1998 to 2010.

Data. This research was carried out on the karakul sur-type sheep with platinum shades living in the Republic of Kazakhstan.

Fig. 1. Index selection steps

For breeding, sheep were selected from the flock with regard to selected fur and fur color characteristics: in 1998, there were 2392 sheep with platinum shade of fur in the flock; in 2010, there were only 1700 sheep with this coloring in the flock.

Index selection. Figure 1 presents a guide to the development of an index selection method for breeding karakul sheep.

The selection index for breeding platinum-colored animals was considered to be the proportion of underfur fibers to the total amount of fibers in the coat:

$$\text{PoUFF} = \text{UFF} / \text{TNoH},$$

where PoUFF – the proportion of underfur fibers; UFF – the amount of underfur fibers; TNoH – the total amount of fibers in the coat.

Based on the amount of underfur fibers, 32 elite rams were selected and divided into three groups: Group I – rams with a high proportion of underfur fibers, fibers $\geq 42\%$; Group II – rams with an average proportion of underfur fibers, PoUFF = 40-41%; Group III – rams with low proportion of underfur fibers: $\leq 39\%$ (Tab. 1).

Research materials

Sheep selected using the developed selection index for karakul sur-type sheep breeding. To study color heritability, 2 karakul sur-type rams were selected randomly from each group of elite rams (6 in total) for breeding with Grade I platinum-colored ewes (324).

Karakul sur-type rams of platinum color with semicircular and ribbed pelts (line breed). The fat-tailed Atyrau rams with coarse semicircular-curl and ribbed pelts of platinum, bronze, amber and anthracite colors were selected for breeding with female relatives. Wright's coefficient of inbreeding was used (Fx) (18). The proportion of parental couples: 25.0% (father $\times$ daughter) – 85 females, 12.5% (half-brother $\times$ half-sister) – 83 females, 6.25% (uncle $\times$ nephew) – 86 females, 3.25% (cousin $\times$ cousin) – 346 females. The breeding progress is shown in Figure 2.

Research methods. The offspring were distributed into classes individually according to the Guide to karakul Classing. The following characteristics of the newborn karakul lambs were identified. The

Tab. 1. Platinum-colored lambs, distribution by the proportion of underfur fibers

Indicator	No. of lambs	Selection index value							
		37	38	39	40	41	42	43	44
Frequency of occurrence, lambs	32	1	2	5	8	6	6	3	1
Lambs with selected trait to 100 lambs, %	100	3.1	6.2	15.6	25.0	18.8	18.8	9.4	3.1

Fig. 2. The line breeding of karakul sur-type sheep

length of fibers on the rump was measured in mm using a millimeter ruler. The length and width of curls on the rump were measured in mm using the same ruler. The sheepskin area was measured in mm by multiplying the length of a sheepskin by its width. The wool was weighted using a dial scale “Gometer” within the accuracy of 5 g. The pelt thickness was measured on the rump using a thickness gauge “Textilmash” within the accuracy of 0.1 mm. The shine and silkiness of wool were determined visually (3).

Animal growth and development were studied by taking the live weight and linear body measurements: at birth, at the age of 4-4.5 and 12 months. The results of measurements were used to calculate the selection index.

Samples of 60-70 g wool were washed in a solution of xylene, then rinsed in distilled water, and put into 96% and 70% alcohol. At the end, fibers were dried to constant weight on the filter paper. The line breeding coefficient was calculated according to Kravchenko (5).

The wool-producing ability of sheep was determined by cutting off fibers at different ages during the spring and autumn shearing. The wool length was measured according to methodology published by the All-Russia Research Institute for Animal Husbandry (VIZh).

Data analysis. Data were entered into Origin 9.1. The analysis was performed using STATA 12.0 (StataCorp LP, USA). The prevalence of platinum coloring was determined using the 95% confidence interval, $P \leq 0.05$.

Results and discussion

The index selection of Kazakh karakul sheep. The authors have carried out studies to determine the proportion of underfur fibers in selected sheep (Tab. 2). The study of platinum-colored rams shows the proportion of underfur fibers at the level between 36% and 44% of the total number of fibers in the coat.

The frequency of occurrence of platinum-colored lambs with high

Tab. 2. Platinum-colored rams selected for breeding, grouped by the proportion of underfur fibers

Selection index value, %	No. of rams	Frequency of occurrence, %
High proportion of underfur fibers, $\geq 42\%$	10	31.25
Average proportion of underfur fibers, 40-41%	14	43.75
Low proportion of underfur fibers, $\leq 39\%$	8	25.0
Total across groups	32	100.0

Tab. 3. Characteristics of rams: mean measurements and variation

Characteristic	Measurements	δ	C_v
Straight fiber length, mm	12.8 ± 0.27	1.52	11.93
Curl length, mm	46.4 ± 1.80	10.18	21.94
Curl width, mm	9.6 ± 0.27	1.53	15.91
Curliness, %	67.4 ± 2.60	14.71	21.82
Live weight, kg	4.2 ± 0.08	0.45	10.78

proportion of underfur fibers was 31.25% (10 lambs), with an average proportion of underfur fibers – 43.75% (14 lambs), with low proportion of underfur fibers – 25% (8 lambs).

Table 3 shows the mean measurements and the variation of characteristics found in selected rams.

Platinum color heritability in Kazakh sur-type sheep (line breeding). Second generation offspring included 1.9% higher number of lambs with platinum shades; 2.2% higher number of lambs with bronze shades; 2.1% higher number of lambs with amber shades; and 2.2% higher number of anthracite shades, $P > 0.05$. These lambs were also larger in size by 4.5%. The difference between second generation karakuls and the purebred karakuls was as follows: difference in platinum coloration – 34.7%; in bronze coloration – 32.7%; in amber coloration – 34.8%; in anthracite coloration – 30.3%, $P < 0.001$. The difference in curl size varies between lambs born from rams of different colors: from platinum rams – 30.8%, from bronze rams – 29.1%, from amber rams – 31%, from anthracite rams – 26.6%, $P < 0.001$.

The analysis of color heritability in karakul sur-type sheep shows that in line breeding, the inheritance of coloration is stable (Tab. 4). In line breeding, platinum color inheritance was 85.85%-87.27%. The difference

Tab. 4. Platinum color inheritance in karakul sur-type sheep, in %

Rams grouped by the proportion of underfur fibers (PoUFF)	No. of rams	Colors			Others
		platinum	bronze	amber	
Group I PoUFF $\geq 42\%$	106	34.94 ± 4.63	5.66 ± 2.24	4.72 ± 2.06	54.72 ± 4.83
Group II PoUFF = 40-41%	102	59.86 ± 4.85	4.90 ± 2.14	2.94 ± 1.67	32.36 ± 4.63
Group III PoUFF $\leq 39\%$	110	87.27 ± 3.18	4.55 ± 1.98	4.54 ± 1.98	3.64 ± 1.78
Total across groups	318	61.00 ± 1.92	5.03 ± 1.22	4.40 ± 1.15	4.09 ± 1.11

in the inherited trait between groups was insignificant 0.99-1.42% ($P > 0.05$). From this one can assume that the PoUFF index is not sensitive to the level of platinum color inheritance. Therefore, breeding can be conducted within all groups.

Platinum color inheritance. Table 5 shows that platinum color is inherited stably. The share of sur-type sheep with platinum shades was between 85.85% and 87.27% (CI: 11.55-13.97).

Table 6 shows that inherited color distributes across the coat with evenness, which is also stably inherited. The share of sur-type sheep with even coloration was between 66.04% and 87.27% (CI: 14.35-27.44). The highest level of inheritance (87.27%) was observed in the third group. It was 8.84% higher than in the second group, where it was 78.43%, and 21.23% higher than in the first group, where it was 66.04%, $P > 0.05$.

In the third group, the share of offspring with uneven coloration or gradually pigmented offspring was low. Color evenness characterizes the distribution of color across the lamb's body (6).

As can be seen from Table 7, coloration is inherited at the high level, which varies between 3.21% and 79.0% (CI: 13.05-20.36). The highest level of inheritance (79.0%) was observed in the third group. It was 7.43% higher than in the second group, where it was 71.57%, and 15.77% higher than in the first group, $P > 0.05$.

Coloration was investigated in those lambs that had the selection index value under average. According to Baibekov, the proportion of guard hairs in gray lambs was 36.5%. In line breeds, this figure grows up to 40.7%. With age, the proportion of guard hairs increases by 2-6% (2).

At this point, grey karakuls have homozygosis for a dominant feature (4). Therefore, breeding can be carried out in all groups. Nechifor discovered that some karakul sheep have a share of 2% of a different color. This fact confirms that the black color is given by two different genotypes; namely dominant black and recessive black, and that these genotypes differ from each other by the fact that the recessive one favors the occurrence of other colors, often brown and grey (9).

Nel observed that karakul sheep with grey-brown fibers usually bear dark-grey lambs (10). It should be noted that studies of sur color genetics remain open-ended. The earlier studies found that the degree of pigmentation to some extent depends on the value of the wool fineness (7, 8).

The advantage of this technique is that it allows for successfully breeding early-maturing Edilbay and Kazakh fat-tailed sheep of original colors, with coarse fur, as well as karakul sheep (Surkhandarya and Karakalpak sur-types). This technique also allows for improving the genetic potential of karakul sheep

Tab. 5. Inherited proportion of underfur fibers

Rams grouped by the proportion of underfur fibers (PoUFF)	No. of rams	Distribution of lambs in a new generation*		
		PoUFF-1	PoUFF-2	PoUFF-3
Group I PoUFF $\geq 42\%$	106	55.66 $\pm$ 4.82	29.25 $\pm$ 4.42	15.09 $\pm$ 3.47
Group II PoUFF = 40-41%	102	17.65 $\pm$ 3.17	65.68 $\pm$ 4.70	16.67 $\pm$ 3.69
Group III PoUFF $\leq 39\%$	110	11.82 $\pm$ 3.08	30.00 $\pm$ 4.36	58.18 $\pm$ 4.70

Explanation: *intra-bred lambs with different proportion of underfur fibers (high, average and low)

Tab. 6. Inherited color evenness

Rams grouped by the proportion of underfur fibers (PoUFF)	No. of rams	Color evenness	
		even	uneven, gradual pigmentation
Group I PoUFF $\geq 42\%$	106	66.04 $\pm$ 4.60	33.96 $\pm$ 4.06
Group II PoUFF = 40-41%	102	78.43 $\pm$ 4.07	21.57 $\pm$ 4.07
Group III PoUFF $\leq 39\%$	110	87.27 $\pm$ 3.18	12.73 $\pm$ 3.18
Total across groups	318	77.36 $\pm$ 2.35	22.64 $\pm$ 2.35

Tab. 7. Inherited coloring, contours

Rams grouped by the proportion of underfur fibers (PoUFF)	No. of rams	Contours	
		strong boundaries between two colors	weak boundaries between two colors
Group I PoUFF $\geq 42\%$	106	63.21 $\pm$ 4.68	36.79 $\pm$ 4.68
Group II PoUFF = 40-41%	102	71.57 $\pm$ 4.46	28.43 $\pm$ 4.46
Group III PoUFF $\leq 39\%$	110	79.09 $\pm$ 3.88	20.91 $\pm$ 3.88
Total across groups	318	71.38 $\pm$ 2.53	28.62 $\pm$ 2.53

on live weight, precocity and adaptive capacity. This will help to shorten the breeding time.

This study was about breeding karakul sur-type sheep of leading colors to form highly productive flocks of sheep of desirable types. The following conclusions can be stated:

1. In line breeding, platinum color is inherited at the level between 47% and 52%.

2. An index method was developed for breeding sur-type sheep with the proportion of underfur fibers under 25%. Such a proportion of underfur fibers provides a 15.25% deeper color within the breed at the 25.3% higher chance of getting platinum shades. Platinum coloring in sheep makes them less piebald. The inheritance index is quite stable and is within 55.66-65.66%. In the breeding flock, the initial proportion of sur-type lambs, which could be used in coat making (elite class), was up to 8.72%.

The originally designed method for improving breeding indexes will be useful when setting optimal

breeding goals (fur color and quality) and assessing genetic parameters of sheep flock.

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Corresponding author: Dr. Mukhit Dyusegaliev, Atyrau State University, H. Dosmukhamedov Ave., Student 212, Atyrau, Kazakhstan; e-mail: mukhitdyusegaliev@gmail.com