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GENOTYPICAL PARTICULARITIES OF THE TYPE OF SHEEP MOLDAVIAN KARAKUL

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Abstract

The purpose of the present research was to reveal and evidence the genotypic particularities of the type(race) of sheep Moldavian Karakul. The experiments were performed on sheep populations from the Experimental Household of the National Institute of Zootechnics and Veterinary Medicine (INZMV), and from the Agricultural Cooperative of Production "Agrosargal", Republic of Moldova. Research they demonstrated that the hereditary capabilities of the Moldavian Karakul sheep are well genetically consolidated and are constantly transmitted through descent. In particular, the morpho-productive characters, which determine the quality of the furskin, have significant genotypic (mother-descendant) correlations, such as: loop length ($r=0.47±0.08$; $t_r=5.9$; $P<0.001$); extension of the loop ($r=0.45±0.09$; $t_r=5.6$; $P<0.001$); silk fiber ($r=0.40±0.09$; $t_r=4.4$; $P<0.001$); fiber luster ($r=0.30±0.10$; $t_r=3,0$; $P<0,01$); fiber length ($r=0.30±0.10$; $t_r=3.0$; $P<0.01$); body length of lamb at birth ($r=0.36±0.02$; $t_r=18.0$; $P<0.001$); body mass of lamb at birth ($r=0.30±0.03$; $t_r=10.0$; $P<0.001$) and evaluation class ($r=0.48±0.07$; $t_r=6.8$; $P<0.001$). The large body mass of the sheep (meat production aptitude) is constantly transmitted through heredity. There is an obvious genotypic correlation between this character of the father-rams and the young-descendants ($r=0.55±0.09$). The heritability coefficient of body mass is not high ($h^2=0.3$), but quite significant ($t_r=2.6$; $P<0.01$). The value of the repeatability coefficient (r_w) of body mass at different ages of young sheep and adult sheep is 0.23–0.47. The consolidated genotypic capacities of the Moldavian Karakul sheep are also manifested in the transmission through heredity milk production. The value of the heritability coefficient (h^2) of this character is not high, but quite significant ($h^2=0.316$; $P<0.001$). Most breeding rams have valuable hereditary capabilities. Out of the total 112 rams tested for descendants qualities, 30 rams were recognized as improvers, which is 26.8%. The genotypic qualities of improvers have been repeatedly confirmed. The type of sheep Moldavian Karakul possesses a karyotype with specific genetic characteristics, which is identified by the classical Asian Karakul race and the local race Tusca, after the erythrocyte antigenic markers of the 7 blood groups (A, B, C, D, M , R and I), which include 15 erythrocyte antigens (Aa, Ab, Bb, Bd, Bg, Be, Bi, Ca, Cb, Da, Ma, R, O, I and i). Moldavian Karakul sheep are characterized by a high frequency (0.6005-0.9504) of antigens Bb, Bd, Bg, Be, Ca, Cb, Da, Ma, O and I, a medium frequency (0.3447-0.5796) of antigens Aa and R, as well as a reduced frequency (0.0496-0.2260) of antigens Ab, Bi and i. In the diagram of the genetic clusters, the sheep population Moldavian Karakul occupies an intermediate position in cluster B with the genetic distance of 0.2586, located between the two related populations, as is the local breed Tusca of the cluster A with the genetic distance of 0.1280 and, the race Asian Karakul from cluster C with genetic distance of 0.3154. In the population studied were found 136 genotypes and 48 genetic allele with specific frequencies. The degree of homozygosity of the investigated population constitutes 0.58, which shows sufficient genetic consolidation for the growth "in itself".

***Key words**: race, sheep, Moldavian Karakul, heritability, furskin, milk, antigens.*

INTRODUCTION

According to the communication of Bertone B.F. (official representative of FAO at the first International Symposium for the Karakul race in Vena, 1967), quoted by Ştefănescu et al. (1973), Karakul sheep are raised on all continents of the world, except Oceania.
Analyzing the dynamics and distribution of sheep flocks in the growing countries of Karakul we concluded that, they are concentrated, raised and exploited efficiently in countries and regions that have huge territories of natural pastures, and also poor (Central Asia, Africa), but extended, with a climate that allows them to be maintained throughout the entire calendar year without expensive shelters (Buzu, 2018). In addition, Karakul sheep are also found in some European countries, where the local breeds for milk-furskins are

traditionally grown, such as: Socoliskaia and Resetilovca - in Ukraine, Turcana White and Greyish - in Romania, and Tusca - in the Republic of Moldova.

In the countries of the regions and parts of the above-mentioned world, multiple intraracial types of Karakul sheep have been created, as well as regional types of elite within this world megarace, which are distinguished by a whole range of phenotypic morpho-productive and genotypic particularities.

Thus, in **South West Africa (Namibia)**, using his own specific selection procedures, Tompson (quoted by Филлингер, 1975), he created at the Neydam Experimental Station a new intraracial type of Karakul sheep with flat buckling. According to the communication of Мостерт (1975), at the same Station, through the reciprocal crossings of the Karakul race with the Somali and White African race, a new intraracial type of white Karakul sheep was created. The German researcher Шефер (1975a, 1975b), described the particularities of the heritability of the furskin characters in these types. Нел (1975a, 1975b), he studied the phenotypic and genotypic correlations, as well as the heritability of a furskin character string in the Karakul sheep of South African types, proposed some specific methods of testing the rams according to the descent qualities.

In Uzbekistan, under the influence of Namibian fashion, the karakulists reoriented the selection of Karakul sheep in the direction of creating new types of sheep with flat and costal curls, of different colors and coloration (Buzu, 2016). Thus, Букаев et al. (2016) announces the creation of a new type of elite "Саржальский" of black Karakul sheep with the type of coastal loop. Юсупов et al. (2016) created the new type of elite "Бухароишарифский" of sheep Karakul on silver with the type of flat loop. Рахимов et al. (2016) communicate about the creation of a new type of elite "Сарибельский" of sheep Karakul gray silvery with the type of flat loop. Юсупов et al. (2016) obtained a new type of elite "Авазчульский" of black Karakul sheep with the type of coastal loop. Солиев et al. (2016) created the new type of elite "Узбекистанский - Uzbekistanski" of sheep Karakul gray silvery with the type of looping jacket. Очилов et al. (2016) created the new intra-racial type "Турткульский" of Karakul sheep from the Karakalpak type. About the creation of new types of sheep Karakul in this country of Central Asia informs us Гигинейшвили (1976) and Жиряков (2008).

In Kazakhstan, Шамекенова (2011) communicate on the creation of a new intra-racial type of Karakul gray sheep through the absorption crossings of local Kurdiuk and Edilbaev sheep, with Karakul gray sheep. Юсупбаев (2011) report on the creation of a new intra-racial type of white Karakul sheep "Отырарский", by crossing white sheep for fine wool and black Karakul, with white rams from the Kazakh race of Kurdiuk and white sheep of the Karakul type from Nurata.

Алибаев et al. (2014) created, a new type of elite sheep Karakul greyish of blue colorated. Алимбаев (2011) and Ескара et al. (2014), the communicates on the creation of a new type of elite black sheep Karakul of «Жоматский» with the tubular type loop.

In Romania, SCPCO Popăuţi researchers created a new type of intra-racial (race) Karakul from Botosani, by crossing the black and greyish Turcana sheep and mating with the purebred Karakul sheep (Ştefănescu et al., 1961; Taftă, 1997b; Ursu et al., 1995). Subsequently, genetic improvement of sheep populations was carried out under the pedo-climatic conditions specific to the area, creating within the race lines and new populations with varieties of greyish (Bosânciuc et al., 1994; Filote et al. , 1997), gray, brown and white (Ursu et al., 1994, 1995, 1997; Ursu, 1997), estimating the morpho-productive and genetic parameters of these newly created populations (Bosânciuc et al., 1997; Groza et al., 2014; Nechifor et al., 2015).

In Ukraine, at the Institute of Scientific Research in Animal Husbandry for the Steppe Districts "Askania-Nova", Herson region, according to the communication of Перегон И.Л. (1972), through cross-breeding activities of the Karakul and Romanov races, selection and breeding of artisans of different generations, the researchers managed during the years 1935-1970 to create a new intra-racial type of prolific Karakul sheep with superior performances, compared to the Asian one. The prolific Karakul sheep from Askania are also widespread in the Cernăuţi region, based on which, by crossing with the local sheep, measures are being taken to create a new type of sheep from Karakul of Bucovina (Дронык et al., 2010; Lesyk et al., 2016).

In all the new intra-racial and elite types created by the Karakul sheep, in all the countries and regions where they were created, the creator-authors described, quite broadly and in detail, the morpho-productive phenotypic particularities of the sheep. At the same time, the genotypic particularities of the newly created sheep populations, in most countries (with the exception of South-West Africa, Romania and, in part, Uzbekistan), have not been sufficiently elucidated, which makes it impossible to genotypically compare the biodiversity of genetic resources of the Karakul sheep from the spreading areas of this world megarase.

In South West Africa, the genotypic particularities of the local types of the Karakul race have been largely described by the scientific researchers of the Neydam Experimental Station (Филлингер, 1975; Мостерт, 1975; Шефер, 1975a, 1975b; Нел, 1975a, 1975b), which highlighted the hereditary capacities of the sheep from the populations subjected to selection, determined the genotypic correlations and the heritability coefficients of the main selected characters, described the genetic characteristics of the sheep genealogical lines within the race.

In Uzbekistan, for the first time in the world, at the Union Institute of Scientific Research for Karakultura (Samarkand city), research was carried out on the antigenic factors of blood groups in sheep from the Karakul race, identifying the possibilities of their use as genetic markers in the selection sheep (Ата-Курбанов, 1986).

In Romania, the genotypic characteristics of the type of sheep Karakul de Botosani have been elucidated by describing the hereditary particularities of the color varieties and the genetic parameters for the main properties of the buckling (Ştefănescu et al., 1961; Ursu et al., 1994; Bosânciuc et al., 1994; Bosânciuc, Taftă, 1997; Nechifor et al., 2015), as well as by the inheritance characteristic of the antigenic factors of the blood groups (Hrincă et al., 1989, 1994, 2001; Hrincă, 2012).

In the Republic of Moldova, the genotypic particularities of the Moldavian Karakul sheep have been elucidated by us in separate works describing the hereditary capabilities of the sheep and the breeding value of the reproducing rams (Buzu, 2012, 2015, 2014c), determining the phenotypic and genotypic correlations, as well as the heritability coefficients of the main selected characters (Buzu, 2000, 2001, 2014a, 2014b). Research on the frequency and inheritance of blood group antigenic factors in sheep from local populations was performed for the first time by Люцканов (1990, 2009) and Марзанов (1991).

At the same time, when presenting the materials to the State Commission for the approval of the type of sheep Moldavian Karakul, it was necessary to systematically highlight the genotypic particularities, the comparative characteristic with the original races and the passport of the sheep population after the antigenic markings of the blood groups.

The revealing of these particularities, being the purpose of the present work, is a very current scientific problem.

MATERIALS AND METHODS

The genotypic particularities of the type of sheep Moldavian Karakul have been investigated on the sheep populations from the Experimental Household of the National Institute of Zootechnics and Veterinary Medicine (INZMV) in the village Maximovca, the district Anenii Noi and from the Agricultural Cooperative of Production "Agrosargal", village Sarata Galgenă, Hânceşti district.

These particularities were highlighted based on the research of the hereditary capacities of the sheep for the descending transmission of the main morpho-productive characters: the quality of the furskin, the body mass and the milk production.

Based on establishing the heritability coefficients (h^2) of the characters, the calculations of the squares of the genotypic correlation coefficients, existing between the characters of the parents and their descent, were applied, applying the electronic programs ("STATISTICA-12"), known in the computer

in the biometric processing statistics of population genetics.
The capacities of hereditary transmission of the furskin qualities of the Moldavian Karakul lambs were established following the analysis of the results of the inheritance by the lambs, of the main selected characters, both quantitative and qualitative. The lambs' value was made 1-2 days after birth, according to the Karakul sheep guidelines Instructions with amelioration principles in the Republic of Moldova (Buzu et al., 1996). In order to determine the breeding capacities of the rams breeders, during the creation of the type of sheep, the Moldavian Karakul was carried out their permanent testing according to the qualities of the descent, according to the methods elaborated by us (Buzu, 2014c). At the beginning of the type creation period, the rams were tested only once, regardless of the age at which they were tested. Subsequently, during the period of approval of the new type, the multiple testing (several times) of the rams was applied according to the qualities of the descent. According to the mentioned methods, the rams were divided into different categories and degrees, according to their value of improvement (1st degree improver, 2nd grade improver, ordinary grade improver, or reducer).
During the period of approval of the new type of sheep Moldavian Karakul, using monospecific sera from the INZMV immunodiagnostic bank, the genetic markers (erythrocyte antigens) of 7 blood groups A, B, C, D, M, R and I were investigated, include 15 antigens: Aa, Ab, Bb, Bd, Bg, Be, Bi, Ca, Cb, Da, Ma, R, O, I and i (Люцканов, 1990, 2009). As a result, the characteristics of the Moldavian Karakul sheep population were given according to the antigen, genotype and allele profile in the blood groups, determined the indices of the genetic distances between the related initial races (Asian Karakul and Tusca), constructed the genetic cluster diagram, calculated the degree of homozygosity and the number of efficient alleles. The frequency of antigenic factors, genotypes and alleles in the sheep populations investigated was determined by the methods of Животовский and Машуров (1974).
The indices of the genetic distances between the sheep populations investigated were calculated based on the squared deviations of the summary differences of the antigen frequencies of the blood groups according to the methods of Серебровский (1970).
The analysis of the genetic cluster and the construction of the diagram was performed according to the methods of Машуров and Черкащенко (1987).
The index of the degree of homozygosity and the number of efficient alleles in the sheep populations investigated were determined, according to the methods of Robertson A., 1956.
The data obtained as a result of the researches were processed, systematized and generalized, their certainty being appreciated, according to the variational biometric statistics, according to the methods of Плохинский (1989).

RESULTS AND DISCUSSIONS

The results of the researches showed that, the genotypic particularities of the type of sheep Moldavian Karakul are manifested by the ability to transmit by heredity the main morpho-productive characters selected, through the capacities of genetic improvement of the rams-breeders, as well as by the specific structure of the immunogenetic markers of the groups blood in the systems of the sheep population.

The inheritance of the main productive morph characters.

The degree of heritability of the characters selected in the sheep population can be appreciated both by calculating the genotypic correlations of these characters between parents and descent, as well as by determining the heritability coefficient (h^2).
In the Karakul race, the furskin characteristics, taken separately, influence the quality of the furskin as a whole, which constitutes a primordial morpho-productive character.
Knowing the degree of their inheritance in the specific sheep population, subject to genetic selection and breeding, is of significant scientific interest, both for the efficiency of the selection process and for the genotypic characteristic of the population (race).
The results of the research of a series of genotypic correlations of the characters, which condition the quality of the furskin as a whole,

showed that, in most of the selected characters, there are correlation coefficients (mother-descendant) of medium and sub-level, with quite significant criteria of certainty (Table 1).

Table 1. Genotypic correlation (mother - descendant) of the main specific furskin characters sheep population Moldavian Karakul

Characters	N	$r \pm m_r$	t_r
Length of the loop	51	0.47 ± 0.08	5.9***
Extension of the loop	49	0.45 ± 0.08	5.6***
Silkiness	43	0.40 ± 0.09	4.4***
Luster	47	0.30 ± 0.10	3.0**
Degree of closure of loops	70	0.09 ± 0.11	0.8
Loop modeling	70	0.09 ± 0.11	0.8
Modeling type	70	0.12 ± 0.11	1.1
Fiber sowing	70	0.10 ± 0.10	1.0
Reserve the skin	70	0.08 ± 0.11	0.7
Constitution	47	0.06 ± 0.14	0.4
Body length lamb at birth	65	0.36 ± 0.02	18.0***
Lean body mass lamb at birth	41	0.30 ± 0.03	10.0***
Class at evaluation	49	0.48 ± 0.07	6.8***

Remark: $^{**}t_r < 0.01$; $^{***}t_r < 0.001$.

The results obtained allow us to find that, in the type of sheep Moldavian Karakul, hereditary capacities are sufficiently consolidated, a fact confirmed by the existence of a series of highly significant genotypic correlations. This refers, first of all, to the most important morpho-productive characters that determine the quality of the furskin and its surface, such as: the length of the loop, the extension of the loops, the silkiness and the luster of the hair fibers, the body mass of the lambs at birth, the length of the body and the class of evaluation.

Of the basic characters, which allow the appreciation of hereditary capacities for the production of furskins, they are constantly inherited and have significant genetic correlation the length of the loop (r = 0.47 ± 0.08), the extension of the loop (r = 0.45 ± 0.09), silkiness (r = 0.40 ± 0.09) and fiber luster (r = 0.30 ± 0.10). This fact is extremely important for increasing the efficiency of the selection of furskin qualities in the new type of sheep. Highly significant genotypic correlations also exist at the body mass of lambs at birth (r = 0.30 ± 0.03; t_r = 10.0; P <0.001) as well as at body length (r = 0.36±0.02; t_r = 18.0; P <0.001). These indices are very important for the creation of the new type of corpulent Moldavian Karakul sheep. Individuals with body length and large body mass were continuously selected for reproduction throughout the entire breeding period.

Genetic correlation with significant mean values (r = 0.48 ± 0.07) was also recorded at the inheritance of the most important polygenic character, such as the lamb evaluation class, given that it is a synthetic character, which accumulate a range of qualities of the furskin, appreciated in lamb during the evaluation.

It is remarkable that, the new type of sheep Moldavian Karakul constantly transmits by heredity not only the qualities of furskin, but also other production skills, such as the large body mass (meat production ability) of sheep at all ages. In our previous research (Buzu, 2012, 2014a) it has been demonstrated that, between the body mass of the rams and the body mass of the descent at birth there is an obvious genotypic correlation (r = 0.55 ± 0.09). The heritability coefficient of body mass is not high (h^2 = 0.3), but quite significant (t_r = 2.6; P <0.01). This is also confirmed by the fact that the body mass of the young Moldavian Karakul sheep has a fairly obvious repeatability at different ages and periods of ontogenetic development, including until adulthood.

The value of the coefficient of repeatability (r_w) of the body mass at different ages of the young sheep, as well as in the adult sheep, varies between 0.23 and 0.47 (Table 2).

Table 2. Genetic repeatability (r_w) of body mass in young sheep Moldavian Karakul

The age of the young sheep	The value coefficient of repeatability, $r_w \pm m_r$	The criterion of certainty, t_{rw}	The certainty threshold after the Student
At birth - 20 days	0.47 ± 0.07	6.7	P < 0.001
At birth –90 days	0.39 ± 0.09	4.3	P < 0.001
At birth - 6 months	0.26 ± 0.08	3.2	P < 0.01
At birth-18 months	0.23 ± 0.09	2.6	P < 0.01
In adulthood	0.25 ± 0.09	2.8	P < 0.01

This means that the more young the sheep develops at an early age, the greater the adult sheep mass will be.

These parameters confirm the fact that the type of Moldavian Karakul sheep has a high inheritance of high body mass, and the selection of sheep according to this important morpho-productive character of the youth at different ages, as well as in the adult age of the sheep, is quite effective.

The genotypic capabilities of the type of Moldavian Karakul sheep are also manifested in the transmission by hereditary of such a polygenic character, as is the milk production.

Our previous research (Buzu, 2014b) has shown that, from parents with increased milk production, in principle, offspring with increased milk production skills are obtained (Table 3).

Table 3. Milk production of Moldavian Karakul daughter sheep according to the productivity of mothers

Milk production a mother-sheep, kg	Daughter's milk production, kg			
	N	M ± m	σ	C_v, %
> 110	7	87.10 ± 8.24***	21.77	25.0
90 - 109	13	77.69 ± 4.51***	16.40	16.5
70 - 89	21	68.10 ± 5.37*	24.60	36.1
50 - 69	28	65.36 ± 3.23**	17.10	26.2
< 50	8	48.75 ± 5.18	14.57	29.9

Remark: * - P < 0.05; ** - P < 0.01; *** - P < 0.001; Compared to daughters of the mother batch„<50 kg

Thus, from mother sheep with low milk production, up to 50kg, were obtained daughter offspring with low milk production (48.75 kg). With the increase of the milk productivity level of the mother sheep from 50 kg to 109 kg, the milk production of the daughters increased on average by 28.94 kg or 59.4% (P<0.001). The highest milk production (87.10 kg) was obtained from the daughters of the mother-sheep who had the highest milk quantity, over 110 kg.

The analysis of these data confirms that the milk production skills in sheep are constantly transmitted through heredity.

The hereditary power and the degree of influence of the parents on the structure of the genetic variability of the offspring after milk production, are determined by the value of the heritability coefficient (h^2), which in our research was not high, but quite significant ($h^2 = 0.316$; P <0.001), being in accordance with the level 0.3-0.4 of the information of Taftă et al. (1997a).

The research data confirm that the third part of the general phenotypic variability of the character of milk production is conditioned by the inheritance of the parents, and the other two thirds of variability of this character are according to other factors, mainly external ones, which generates a variability quite broad phenotypic. The coefficient of variation (C_V) of milk production is quite high, falling in values from 16.5 to 48.6%.

At the same time, this variability of milk production indicates the fact that there are still wide possibilities for the selection of sheep population by this important productive character.

From the data presented above we can conclude that, one of the genotypic particularities of the type of Moldavian Karakul sheep is the constant inheritance of the main selected characters, which demonstrates the sufficient genetic consolidation of the new type of sheep created and the possibility of maintaining at a high level, as well as of further enhancing the productive potential of this type.

Improver capabilities of ram-reproductive.

One of the genotypic particularities of the type of Moldavian Karakul sheep presents the improver capacities of the ram-reproductive, which are selected and used for reproduction with a high intensity. The most valuable reproductive are considered those rams, who have confirmed their improver status in multiple tests carried out in several years in a row, on different categories of females with different types of curl and evaluation classes. These rams possess a valuable genotype with well-established heredity.

During the period of approval of the type of Moldavian Karakul sheep, during the five years, a total of 112 breeding rams were tested, including 46 heads in the experimental household of the National Institute of Zootechnics and Veterinary Medicine (INZMV) and 66 heads in the Agricultural Cooperative of Production «Agrosargal» (Table 4).

Of the group of rams tested according to the descent qualities of INZMV, 34 rams were tested once, 2 rams - twice (doublutest), 5 rams - tripletest and 5 other rams were tested four and more times.

Table 4. Test results of reproducing rams by descent qualities over five years

Specification	INZMV	«Agro-sargal»	Total
Total rams tested, heads	46	66	112
including: unitest	34	47	81
doubletest	2	12	14
tripletest	5	5	10
cvadrutest and above	5	2	7
Total improver were found, heads	11	19	30
% of total	23.9	28.8	26.8
inclusive:			
1st grade improver	2	7	9
II grade improver	2	1	3
ordinary grade improver	7	11	18
They confirmed the value of the improver, heads:			
once	6	12	18
twice	2	4	6
three times	3	3	6

At ACP «Agrosargal» 47 rams were unitested, doubletested -12 heads, tripletested - 5 heads and quadrutested - 2 rams. In total, 81 reproductive ramsthey were only tested once, twice -14 rams, three times -10 rams and four times more -7 rams were tested at both sheep farms once.

According to the results of the descent testing in the two households, more than ¼ of the tested rams were recognized improver. In both farms, 30 improver rams were found out of the total 112 rams, which is 26.8%.

At INZMV were revealed 11 of the 46 test ramsimprovers, which is 23.9%. At the CAP «Agrosargal» were revealed 19 improver rams - which makes up 28.8% of the rams tested. In the group of rams improver of superior value rate (I degree improver) were divided into a total of 9 rams, including 2 - in farm INZMV 7 - in CAP "Agrosagal". They were assigned the highest category of improver.Three rams were assigned to the category - 2nd grade improver, of which 2 heads at the INZMV farm and 1 head at the CAP «Agrosargal». Ordinary improvers totaled 18 heads, including 7 heads at INZMV farm and 11 heads at CAP «Agrosargal».

According to the test results, they have repeatedly confirmed the value of 12 improver ramsreproducing. At the INZMV farm, 2 rams confirmed their improver value twice, and 3 rams - three times.

At the CAP farm "Agrosargal", 4 rams were confirmed twice the value of improver for the flock in which they were used, and 3 rams - three times.

Based on the data presented, we can conclude that reproducing rams, which have been used for breeding new intraracial sheep, are quite valuable and preponderant. The genetic qualities of improvers have been repeatedly confirmed.

From these rams in the herd, numerous valuable descendants were obtained, which inherited the superior morpho-productive qualities of the improver parents and contributed to the genetic improvement of the population in subsequent generations. The most valuable individuals of these generations were selected as founders and continuators of the elite lines (Buzu I., 2015).

Antigen frequency of blood groups and genetic distances.

The research results of the erythrocyte antigenic factors of the 7 blood groups (A, B, C, D, M, R, I), which include 15 erythrocyte antigens (Aa, Ab, Bb, Bd, Bg, Be, Bi, Ca, Cb, Da, Ma, R, O, I, i) they demonstrated the type (race) of Moldavian Karakul sheep possesses a karyotype with specific genetic characteristics, which identifies it highlighted by the classical sheep race of Asian Karakul, as well as by the local race Tusca.

Research on the immunogenic characteristics of sheep has shown that, in Moldavian Karakul sheep, they have a high frequency of antigens Bb, Bd, Bg, Be, Ca, Cb, Da, Ma, O and I, an average frequency of antigens Aa and R, and , a reduced (low) frequency of Ab, Bi and i. antigens (Table 5).

In the Tusca race, it was found that animals of both colours (greyish and black) were characterized by a certain similarity of blood factors, namely, by the high frequency of antigens Aa, Ma and I (0.6226 - 0.9275), low antigen of Be and R (0.1698 - 0.2754) and average of antigens Bb, Ca, O and i (0.3188 - 0.4928).

Between the greyish and the black sheep, essential differences in antigen frequency were not detected.

In order to improve the furskin qualities of the Tusca race, at the first stage of creation the type, have been used the pure-race Asian Karakul rams were imported from Uzbekistan.

Table 5. Frequency of antigens in sheep races Karakul and Tusca

System	Antigen	Moldavian Karakul (N=383)	Tusca		Asian Karakul (N=113)
			greyish (N=53)	black (N=69)	
A	Aa	0.5796	0.6226	0.6956	0.2920
	Ab	0.1514	0.3019	0.1159	0.3197
B	Bb	0.6527	0.3774	0.4928	0.8407
	Bd	0.6867	-	-	-
	Bg	0.7232	-	-	-
	Be	0.6266	0.2642	0.2464	0.6637
	Bi	0.2260	-	-	-
C	Ca	0.9060	0.3396	0.4783	0.1239
	Cb	0.7467	0.6226	0.3768	0.5398
D	Da	0.7415	0.6226	0.5508	0.8673
M	Ma	0.8172	0.8868	0.9275	0.9735
R	R	0.3447	0.1698	0.2754	0.7522
	O	0.6005	0.4528	0.4203	0.2478
I	i	0.0496	0.3584	0.3188	0.0000
	I	0.9504	0.6416	0.6812	1.0000

As a result, the immunogenetics of new type sheep has undergone changes in the structure of antigens, genotypes and alleles.

According to the analyzes carried out, the newly created type inherited from the imported sheep a high frequency of Bb, Be and I antigens, and from the local breed Tusca of black colour - Cb antigen.

As a result of the marked genetic restructuring within the Aa antigen, the frequency of which was high in the local population of Tusca and reduced to that imported from Uzbekistan, the new type currently has an average frequency according to this factor. The same change also occurred within the R antigen, in particular that its frequency, in the initial race Tusca, was reduced, and in the Asian - Karakul breed - high, as a result, in the Moldavian Karakul type, the frequency of the R antigen is average (0, 3447).

It has also been found that the reduced frequency of the Ab type antigen in the new type was inherited from the black-colored Tusca sheep. The frequency of Ma and I antigens in all three populations, studied, is quite high.

Based on the immunogenetic analysis and the frequency calculations of the antigenic factors, the genetic distances were determined and the analysis of the genetic clusters was performed in their diagram (Fig. 1).

The obtained data demonstrates that the smallest genetic distance (0.1280) is between the sheep Tusca race at the black and greyish colour, which make up the cluster A.

C (0.3154)			**Asian Karakul**
	B (0.2586)		**Moldavian Karakul**
		A (0.1280)	**Greyish and black Tusca**
. . . 0.3	. . . . . . 0.2	. . . . 0.1 0	

Figure 1. Diagram of genetic clusters of Karakul and Tusca sheep populations

Within cluster B, the new type of sheep Moldavian Karakul has a tangency, both with the local race Tusca and with the Asian Karakul race.

Thus, according to the genetic distance (0.2586) the new type sheep population occupies an intermediate position between the two related populations.

The pure Karakul race, imported from Uzbekistan, is at the greatest genetic distance, namely at point C (0.3154), which reflects its interrelation with the Tusca race and the type of Moldavian Karakul sheep.

Thus, the diagram analyzed confirms that the new type of Moldavian Karakul sheep corpulent, for the milk - furskins, has a specific genome of antigenic frequencies and was created by the method of crossing two different races, with the subsequent selection of the requested genotypes, according to the standard-purpose.

Genotypes and genetic references.

By analyzing the phenotypes of the families, the frequencies of the genotypes were detected and calculated in the Moldavian Karakul sheep population (Table 6).

Overall, 136 genotypes were detected by type. The highest frequency of genotypes is found in system A, D, M and I.

Table 6. Frequency of genotypes in the Moldavian Karakul sheep population

System	Its genotype and frequency			
A	a/a - 0.2115 a/- - 0.2402	a/b - 0.0679 ab/- - 0.0366	b/b - 0.0131 b/- - 0.0339	-/- - 0.3968
B	b/b - 0.0131 b/bg - 0.0026 b/bge - 0.0026 b/bdg - 0.0052 b/bdgi - 0.0026 b/bde - 0.0026 b/g - 0.0052 b/gde - 0.0026 b/ge - 0.0026 b/gei - 0.0026 b/d - 0.0104 b/dg - 0.0287 b/dge - 0.0131 b/dgei - 0.0026 b/de - 0.0157 b/e - 0.0104 b/- - 0.0183 bg/bg - 0.0052 bg/bge - 0.0026 bg/bd - 0.0026 bg/bde - 0.0026 bg/g - 0.0209 bg/ge - 0.0078 bg/d - 0.0862 bg/dg - 0.0052 bg/de - 0.0444 bg/dei - 0.0131 bg/di - 0.0052	bg/e - 0.0104 bg/ei - 0.0052 bg/- - 0.0026 bgde/- - 0.0026 bge/bge - 0.0052 bge/g - 0.0026 bge/ge - 0.0026 bge/d - 0.0235 bge/e - 0.0078 bge/i - 0.0026 bge/- - 0.0104 bgei/bde - 0.0026 bd/b - 0.0026 bd/g - 0.0052 bd/ge - 0.0052 bd/gei - 0.0026 bd/d - 0.0026 bd/e - 0.0052 bd/- - 0.0104 bdg/b - 0.0026 bdg/g - 0.0026 bdg/d - 0.0104 bdg/e - 0.0209 bdg/ei - 0.0052 bdg/- - 0.0157 bdge/b - 0.0026 bdge/bg - 0.0052 bdge/bdg - 0.0026	bgde/d - 0.0078 bgde/i - 0.0131 bgde/- - 0.0235 bdgei/bge - 0.0026 bdgei/- - 0.0026 bdgi/bge - 0.0026 bdgi/- - 0.0052 bde/b - 0.0052 bde/g - 0.0078 bde/gi - 0.0026 bde/d - 0.0052 bde/i - 0.0026 bde/- - 0.0026 be/g - 0.0052 be/d - 0.0052 be/dg - 0.0052 be/- - 0.0078 bei/g - 0.0026 bei/dg - 0.0052 bi/dge - 0.0052 bi/e - 0.0026 g/g - 0.0131 g/gei - 0.0026 g/d - 0.0078 g/e - 0.0261 g/- - 0.0209 g/ge - 0.0052 ge/- - 0.0052	gi/e - 0.0026 d/g - 0.0235 d/ge - 0.0104 d/gei - 0.0026 d/d - 0.0157 d/de - 0.0052 d/e - 0.0078 d/- - 0.0209 dg/d - 0.0104 dg/dg - 0.0026 dg/e - 0.0104 dg/ei - 0.0052 dg/- - 0.0104 dge/e - 0.0026 dge/- - 0.0131 dgi/g - 0.0026 dgi/d - 0.0026 de/g - 0.0104 de/gi - 0.0052 de/d - 0.0026 de/de - 0.0131 de/e - 0.0052 e/e - 0.0235 e/- - 0.0418 ei/d - 0.0026 -/- - 0.0131
C	a/a - 0.1880 a/- - 0.0287	a/b - 0.6868 ab/- - 0.0026	b/b - 0.0496 b/- - 0.0104	-/- - 0.0339
D	a/a - 0.5196	a/- - 0.2089	-/- - 0.2715	
M	a/a - 0.7180	a/- - 0.1070	-/- - 0.1750	
R	RR - 0.1621	Rr - 0.2033	rr - 0.6346	
I	II - 0.9373	Ii - 0.0131	ii - 0.0496	

In system A, the highest frequency had the genotypes -/- (hyphen/hyphen) and a/-, constituting 0.3968 and 0.2402 respectively.

In system B the frequency of genotypes is generally quite low. In this system, the highest frequency is at genotypes $B^{bg/d}$ - 0.0862, $B^{bg/de}$ - 0.0444, $B^{e/-}$ -0.0418, $B^{b/dg}$ - 0.0287 and $B^{g/e}$ - 0.0261.

Basically, it was found that, compared to other systems, the frequency of genotypes in system B is the lowest, obviously, out of the total number of genotypes, 67-74% are genotypes with frequency below 0.01.

This phenomenon indicates that, in the created type, high heterozygosity can be maintained, without returning to infusion with other types of sheep Karakul.

In system C, as well as in system A, 7 genotypes were detected, including 3 homozygotes and 4 heterozygotes. The highest frequency of homozygotes is in the $C^{a/a}$ genotype - 0.1880, and in the heterozygotes, in the $C^{a/b}$ genotype - 0.6868. Of all the genotypes in this system, the lowest frequency is at $C^{ab/-}$ - 0.0026 genotype.

Regarding the other systems (D, M, R and I), 3 genotypes were detected, of which 2-homozygous and 1-heterozygous. The most common genotypes in the nominated system sare: $D^{a/a}$ - 0.5196, $M^{a/a}$ - 0.7180, $R^{r/r}$ - 0.6346 and II - 0.9373.

Along with determining the frequency of genotypes, the frequency of alleles, which is closely related to each other, was calculated. A total of 48 alleles were detected in the sheep population analyzed (Table 7).

Table 7. Frequency of alleles in the type Moldavian Karakul sheep

System	Alleles and their frequency			
A	A^a - 0.3655	A^b - 0.0640	A^{ab} - 0.0183	A^- - 0.5522
B	B^b - 0.0836 B^g - 0.0862 B^d - 0.1397 B^e - 0.1031 B^i - 0.0091 B^{bg-} - 0.1084 B^{bd} - 0.0183 B^{be} - 0.0117	B^{bi} - 0.0039 B^{ge} - 0.0196 B^{gi} - 0.0052 B^{dg} - 0.0431 B^{de} - 0.0509 B^{di} - 0.0026 B^{ei} - 0.0091 B^{bge} - 0.0379	B^{bgde} - 0.0235 B^{bgei} - 0.0013 B^{bdg} - 0.0313 B^{bdge} - 0.0052 B^{bdgi} - 0.0052 B^{bdgei} - 0.0026 B^{bde} - 0.0170 B^{bei} - 0.0039	B^{bde} - 0.0170 B^{gde} - 0.0013 B^{dge} - 0.0170 B^{dgi} - 0.0039 B^{dgei} - 0.0013 B^{dei} - 0.0065 B^{gei} - 0.0052 B^- - 0.1110
C	C^a - 0.5457	C^b - 0.3981	C^{ab} - 0.0013	C^- - 0.0548
D	D^a - 0.6240	D^- - 0.3760	-	-
M	M^a - 0.7715	M^- - 0.2285	-	-
R	R - 0.2637	r - 0.7363	-	-
I	I - 0.9439	i - 0.0561	-	-

In system A, a high frequency of the A^- - (0.5522) and low - of the A^{ab} - (0.0183) allele was detected.

System B contains a multitude of alleles, similar to those of the aforementioned genotypes.

Thus, by a comparatively higher frequency, the alleles B^d - 0.1397, B^- - 0.1110, B^{bg} - 0.1084 and B^e - 0.1031 are distinguished. A slightly lower frequency is at allele B^g - 0.0862 and allele B^b - 0.0836. With regard to the other 26 alleles of this system, a reduced frequency was established in most cases.

Within system C, the highest frequency has the C^a allele - 0.5457, and the lowest one - the C^{ab} allele - 0.0013.

Regarding systems D, M, R, and I it was found that the synthesis of red cell antigens is controlled by two alleles. High frequency alleles in these systems include: D^a (0.6240), M^a (0.7715), R^r (0.7363), and I (0.9439). The lowest frequency in these four systems was found in alleles M^- (0.2285), R (0.2637) and I^i (0.0561).

These are the characteristics of the frequency characteristics of the immunogenetic alleles of the new type of Moldavian Karakul sheep.

Degree of homozygosity.

Particular importance for the genetic and zootechnical characteristics of the races and types of sheep is determined by the degree of hetero- and homozygosity, which can confirm the effectiveness of the selection process and the genetic improvement works.

Following the analyzes carried out, the level of homozygosity and allele efficiency in the population of Moldavian Karakul was calculated (Table 8).

Table 8. Degree of homozygosity and allele efficiency in the Moldavian Karakul sheep population

System	Degree of homozygosity	Number of efficient alleles
A	0.62	1.6129
B	0.10	10.000
C	0.27	3.7037
D	0.89	1.1236
M	0.40	2.5000
R	0.79	1.2658
I	0.99	1.0101
General	0.58	3.0309

The data show that the degree of homozygosity in the blood group systems in the new type of sheep is different, depending on the antigenic system.

The highest degree of homozygosity was recorded in systems I (0.99), D (0.89), R (0.79) and A (0.62). A lower degree of homozygosity was found in systems B (0.10), C (0.27) and M (0.40). The general homozygosity in the sheep population Moldavian Karakul constituted 0.58. The degree of homozygosity greater than 0.50 demonstrates sufficient genetic consolidation of the newly created races and types.

The highest allele efficiency was recorded in system B (10.0) and C (3.704). The overall efficiency per allele is 3.0309 and falls within the medium limits of sufficiently efficient characteristic of the selection process.

Therefore, based on the immunogenic characteristics we can conclude that, the new type of sheep Moldavian Karakul is genetically well consolidated, having a karyotype with a specific genetic structure, which distinguishes it from other types within the Karakul race.

CONCLUSIONS

The main genotypic particularity of the type (race) of Moldavian Karakul sheep is that, the hereditary capacities of the sheep are well consolidated genetically and are constantly transmitted through descent.

In particular, the morpho-productive characters, which determine the quality of the furskin, have significant genotypic (mother-descendant) correlations, such as: loop length (r=0.47±0.08; t_r = 5.9; P <0.001); extension of the loop (r = 0.45±0.09; t_r = 5.6; P <0.001); silk fiber (r = 0.40±0.09; t_r = 4.4; P <0.001); fiber luster (r = 0.30±0.10; t_r = 3.0; P <0.01); body length of lamb at birth (r = 0.36±0.02; t_r = 18.0; P <0.001); body mass of lamb at birth (r = 0.30 ±0.03; t_r = 10.0; P <0.001) and evaluation class (r = 0.48±0.07; t_r = 6.8; P < 0.001).

The large body mass of the sheep (meat production aptitude) is constantly transmitted through heredity. Between the body mass of the father-rams and the body mass of the descent at birth there is an obvious genotypic correlation (r = 0.55±0.09). The heritability coefficient of body mass is not high (h^2 = 0.3), but quite significant (t_r = 2.6; P <0.01).

The value of the coefficient of repeatability (r_w) of body mass at different ages of young sheep and adult sheep is 0.23–0.47.

The consolidated genotypic capacities of the type of Moldavian Karakul sheep are also manifested when transmitting milk production through hereditary. The value of the heritability coefficient (h^2) is not high, but quite significant (h^2 = 0.316; P <0.001).

Most breeding rams have valuable hereditary capabilities. Out of the total 112 rams tested for descent qualities, 30 rams were recognized as improvers, which is 26.8%.

The genotypic qualities of improver have been repeatedly confirmed. Breeding rams were still used to for reproduction new type sheep.

The type (sheep) of the Moldavian Karakul sheep has a karyotype with specific genetic characteristics, which is identified by the classical Asian Karakul race and the local race Tusca, after the erythrocyte antigenic markers of the 7 blood groups (A, B, C, D, M , R and I), which include 15 red cell antigens (Aa, Ab, Bb, Bd, Bg, Be, Bi, Ca, Cb, Da, Ma, R, O, I and i).

Moldavian Karakul sheep are characterized by a high frequency (0,6005-0,9504) of antigens Bb, Bd, Bg, Be, Ca, Cb, Da, Ma, O and I, a medium frequency (0.3447-0.5796) of antigens Aa, R and, a reduced frequency (0.0496-0.2260) of antigens Ab, Bi and i.

In the diagram of the genetic clusters, the sheep population Moldavian Karakul occupies an intermediate position in cluster B, between the two related populations with a genetic distance of 0.2586, compared to the local raceTusca of the cluster A with the genetic distance of 0.1280 and in front by the Asian Karakul of the C cluster with the genetic distance of 0.3154.

Overall, by type, 136 genotypes and 48 alleles with specific frequencies were detected. The degree of homozygosity as a whole by type constitutes 0.58, which shows sufficient genetic consolidation for the growth "in itself".

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