Heritability of breeding traits in meat breeds of sheep of different origin in the south-east of Kazakhstan

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Abstract: The productivity of sheep depends on a number of quantitative characteristics and, above all, on the live weight, clip, length, fineness, and density of wool. The article presents the nature of the heritability of these traits in meat breeds of Etti merino, Dohne, and Australian meat merino breeds imported to the foothills of the southeastern region of Kazakhstan. It has been established that the efficiency of breeding in experimental sheep depends on the degree of heritability of the bred trait, and that the improvement of productive traits of sheep largely depends on their heritability and variability. As a result of comparing the level of development of live weight, clip, density, length, and fineness of wool by the method of a single-factor variance complex, it was found that the genotypic diversity of economically useful traits in experimental animals is mainly objective. This is especially noticeable when determining the live weight and clip of wool from mother-sheep and daughter-sheep received from them at the same age. Moreover, the older the animals, the clearer this manifestation becomes. Approximately the same pattern is observed in both the density and length of the wool.
Keywords: Etti merino, Dohne, Australian meat merino, heritability, live weight, clip, wool density, length and fineness of wool

1 Introduction

Most of the bred sheep traits used in selection are quantitative traits, and the multiple changes that occur during growth and development affect them. The development of an organism is carried out as a single process under the influence of its heredity and environmental conditions [1]. Therefore, the study of this issue has a great importance and is directly related to practical issues of experimental evolution.

As it is known, the analysis of quantitative traits of individual animals is based on the principles of population genetics, since the distribution of hereditary variability among individuals of a population is determined not by gene frequencies but by genotypes and population-genetic traits acting on them [2].

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Along with the inheritance of quantitative traits, the heritability coefficient (h^2) is one of the most important parameters for genetic analysis [3].

The heritability of quantitative traits is a property not only of the studied traits, but also of the population represented by these groups of individuals, and therefore of the environmental conditions to which this population is exposed [4].

The theoretical relevance and practical significance of studying the heritability of economically useful traits in sheep of meat breeds are acquired during mass breeding by phenotype, since they affect the effectiveness of breeding and prediction of the effectiveness of selection of the main productive traits.

2 Materials and methods

The experimental part of the work was carried out at the Akbulak farm in the Almaty region. The research material was sheep of meat breeds: Etti merino (group 1), Dohne (group 2), and Australian meat merino (group 3). 50 ewes of the above-mentioned breeds were involved in the experiment.

The animals are 1, 2, and 3 years old. The animals were similar in age, live weight, and fatness.

The live weight was determined at one-year-old, 2-, and 3-year-old ages during the shearing period with an accuracy of 0.1 kg.

Wool productivity was studied in experimental animals by individually accounting for wool clip at one-year-old, 2-, and 3-year-olds. Laboratory studies of fleeces and wool samples were carried out using the L.K. Ernst Federal Research Center for Animal Husbandry's technique [5] in the wool laboratories of the Southwest Scientific Research Institute of Livestock and Plant Production.

The heritability coefficients (h^2) were determined by the method of doubled "mother-daughter" correlation and using a single-factor variance complex [6].

The work objective is to study the heritability of economically useful traits in meat breeds of sheep of different origin in the conditions of the foothill zone of southeastern Kazakhstan.

3 Results

The main genetic and statistical indicator that is used to identify the proportion of genotypic variability of traits is the heritability coefficient. The heritability coefficient provides certain information about diversity within a population, which orients the effectiveness of selection, the most important method of genetic improvement of animals. Although there is a need for such an improvement in fine-wool sheep for almost twenty traits, simultaneous inclusion of all of them in the breeding program is irrational, since an increase in the number of bred traits accordingly reduces the effectiveness of breeding for each of them. Therefore, when selecting, it is necessary to take into account only the most important traits that contribute to the maximum yield of high-quality products and the highest rates of breeding progress.

To accurately determine the degree of hereditary conditionality of the studied trait, in the breeding process, along with the selection of more productive individuals, the selection of parental pairs to obtain animals of the desired type is no less important. In the case when the effectiveness of selection is determined by additive genotypic variability among the selected individuals, the success of selection depends to the same extent on the combinative genotypic variability (effects of gene interaction). Moreover, knowledge of the share of genetic diversity due to the effects of gene interaction is no less important for breeding than

additive. The necessary information about the ratio of these shares can be obtained by comparing the heritability coefficient calculated on the same group of animals in the absence of constant paratypical factors for individual sheep.

Our research on the heritability of economically useful traits of experimental groups of sheep at different ages aimed to determine and compare the degree of heritability and the nature of variability depending on the nature of the trait and the origin of the studied groups of animals (Table 1).

Table 1. Heritability of live weight and clip (n=50; ∑n=150).

Ewes, year	Group and breed		
	I	II	III
	EM	Dohne	AuMM
Live weight			
1	0.239±0.22	0.358±0.18	0.165±0.21
2	0.310±0.18	0.497±0.23	0.419±0.22
3	0.575±0.20	0.546±0.19	0.590±0.24
At average	0.375±0.20	0.467±0.20	0.391±0.22
Clip			
1	0.378±0.15	0.319±0.12	0.199±0.20
2	0.425±0.12	0.501±0.15	0.338±0.18
3	0.448±0.13	0.519±0.19	0.391±0.17
At average	0.417±0.13	0.446±0.15	0.309±0.18

The study showed that genotypic diversity is most fully manifested in terms of live weight at different ages, and the older the animals, the clearer this manifestation becomes, and varies between 0.375–0.467. This pattern is obviously associated with significant individual variability in the restructuring of the ewes during the transition from the category of gimmers to adulthood, due to the first pregnancy, lambing, and feeding of lambs.

Regardless of the reason for this pattern, it should be noted that it is not very favorable for breeding based on the assessment of the productive qualities of sheep only in the first year of life, and just as in the case of the repeatability of traits, it obliges to apply correction of this assessment at a later age.

Variations in heritability coefficients at one year of age are not too large, are not of a regular nature and are probably associated with random fluctuations in paratypical factors over certain years (climatic and weather parameters, forage availability in certain periods, etc.), since, similar to correlation coefficients, they do not coincide with changes in productivity indicators reflecting the conditions for the formation of traits.

Wool is an indispensable raw material for the textile industry. The felting quality, hygroscopicity, elasticity and extension of wool as a raw material for the processing industry make necessary breeding of almost twenty of its individual traits and properties, which stimulates increased interest in studying their heritability.

The heritability of the wool properties of sheep of the experimental groups, determined by generally accepted methods and using parent-offspring correlations, is shown in Table 2.

Table 2. Heritability of wool length in sheep of different genotypes, cm.

Group	n	Natural length		True length	
		h^2	td	h^2	td
I EM	50	0.263±0.19	1.3	0.250±0.39	0.53
II Dohne	50	0.495±0.17	1.3	0.565±0.48	0.61
III	50	0.397±0.20	1.7	0.496±0.57	0.49

AuMM					
At average		0.385±0.19	1.43	0.437±0.48	0.54

As it can be seen, a higher heritability coefficient (h2) of the natural length of wool is observed in ewes of groups II and III and, respectively, is 0.495 and 0.397; the lowest is 0.263 in ewes of group I. The heritability of the true length of wool varies between 0.250-0.565. At the same time, the ewes of groups II and III also have a higher heritability coefficient. The fluctuation of the heritability coefficient in experimental groups of animals is apparently due to the different genotypic nature of individuals.

The similarity of genetic diversity between the offspring and parents of experimental groups of sheep serves as the basis of breeding. The amount of similarity in heritability varies with the bred traits, for some of them more, for others less, which affects the value of the heritability coefficient.

The most important qualitative indicators of wool productivity, which ensure the breed expression of sheep in their breeding area, are the density and fineness of wool. Therefore, we are interested in the degree of heritability of the density and fineness of wool. The results of our research show that sufficient amounts of genetic diversity are observed in the density and fineness of wool of experimental ewes, depending on their origin (Table 3).

Judging by the obtained data, the heritability coefficient of wool density in ewes of different genotypes varies between 0.409-0.521. At the same time, the ewes of groups II and III have significant genotypic diversity in the range of 0.521; 0.469.0 with high statistical significance (P>0.999).

Table 3. Heritability of wool density and fineness in ewes of different genotypes, cm.

Group	**n**	**Wool density**		**Wool fineness**	
		h^2	**td**	**h^2**	**td**
I EM	50	0.409±0.51	0.30	0.310±0.16	1.0
II Dohne	50	0.521±0.48	0.60	0.345±0.15	1.3
III AuMM	50	0.469±0.55	0.51	0.433±0.18	1.6
At average		0.466±0.51	0.47	0.329±0.16	1.3

The experimental ewes also showed a relatively high heritability coefficient of wool fineness. However, the share of parental influence on the phenotypic diversity of offspring turned out to be different. It is evidenced by the heritability coefficients of this trait obtained by us, which at one year of age were in the range of 0.310-0.433 with significance (P>0.99). It is generally believed that quantitative traits in animals are determined mainly by the additive type of inheritance. Meanwhile, in the practice of livestock breeding, the proportion of non-genetic factors (feeding and living conditions) is no less high. Moreover, deviations from additive inheritance due to the interaction of "genotype-environment" should be expected to a greater extent in such traits as wool density and fineness, which are more reactive to their interaction.

Thus, the density and fineness of wool in sheep of different genotypes largely depend on the severity of these traits in parents

4 Discussion

Productive traits of sheep refer to quantitative traits, the study of which is due to the polymeric (multiple) action of genes, as a rule, the same or similar effect of many

independent genes on a trait. By studying the heritability of the main indicators of productivity in sheep undergoing breeding, Efimova [7] found that the heritability coefficients of live weight (0.40-0.53), clip (0.53-0.55), and wool length (0.40-0.58) in sheep of imported breeds are approximately the same and quite high in terms of influence. At the same time, the slightly better heritability of live weight (0.53) was in Manych merino sheep, and the heritability of wool length was the lowest (0.40) in Caucasian breed of sheep. In the following studies, Efimova [8] studied the heritability of economically useful traits in bright different genotypes of the Soviet merino and Russian meat merino breeds. As a result, they found that a flock of sheep of the Russian meat merino breed has low heritability coefficients of such traits as wool length and its fineness, in comparison with sheep of the Soviet merino breed (0.27 and 0.38, versus 0.39 and 0.46, respectively). Therefore, it indicates an insufficient consolidation of the flock of a new breed according to these bred traits.

5 Conclusions

As a result of comprehensive research, scientifically based parameters of the heritability of economically useful traits of fine-wool meat breeds of sheep for extreme conditions of the foothill zone of southeastern Kazakhstan have been established.

The identification of the average degree of heritability coefficients indicates its genetic conditionality and the effectiveness of breeding by phenotype, which allows successful breeding by the number of traits at the same time, which accelerates its pace to adjust the assessment and selection of animals in the process of breeding.

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