ESTIMATES OF HERITABILITY COEFFICIENTS IN SOME SHEEP POPULATIONS FROM THE SHEEP BREEDING RESEARCH STATION OF PALAS-CONSTANȚA

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ABSTRACT - *Heritability is one of the most important genetic parameters found in connection with the decisions that must be taken in the breeding processes. The component of the total variation genetically determined depended on the frequency of the gene and on the development of the substitution effect of the gene. The variation of the gene frequency from one population to another and the changes produced by the action of some factors in the same population affected the component of the genetic variance and the ratio of the variance within the population and, finally, the increase of the heritability coefficient. The determination of heritability was necessary especially if populations are found in the middle of the breeding process having the objective of modifying the genetic structure.*

Key words: heritability, estimate, population, genetic variability

INTRODUCTION

Being one of the most important characteristics of metric traits, heritability is a very important indicator on the decisions that must be taken in the process of genetic breeding of animal populations. Genetic differences between populations, specific effects of environment conditions resulted in the determination of stable heritability for each population (Butler, Dolling, 2004; Massey,Vogt, 2002; Massey, Vogt, 2004).

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MATERIALS AND METHODS

For the determination of the average values and of the variability, investigations were conducted on a population from Merino de Palas breed, a dairy and a meat population from the Research Station for Sheep Breeding of Palas-Constanța. The present type of wool population is well genetically structured, being found within the standard of the breed, with a height at withers of 68-76 cm, an average weight of females of 60 kg and of males until 100 kg, a wool quantity of 4-7 kg/ ewe and 8-11 kg /ram, and a great variability of dairy yield.

The dairy population was created after 1975, by crossing the breeds Friză with Spancă and Awassi with Spancă, and after F1, the half- breeds mated among them within the same variant and, then, between the two variants. The average milk yield is of 170 kg in 220 days of lactation, the body weight is of 55-60 kg in ewes and 75-80 kg in rams, the quantity of wool of about 4 kg and the prolificacy of 125%.

The outcrossing was done between the breeds Ile de France with Merino de Palas until F1 and F2, then more series of half-breeds were mated among them, creating the meat population. The body weight of ewes is of 55-60 kg, of rams is of 75-80 kg, the average daily increase, of 200-240 g, with a consumption of 5-5.5 UN/ kg increase , the milk yield, of 60-80 kg in 130 days of milking, the wool yield, of 4 kg and the prolificacy, of 128%.

The statistically determined indicators were:

$$\bar{x};\ s_{\bar{x}};\ s_{\bar{x}};\ V\%$$

For the estimate of quantitative genetic elements, we carried out a study on 71 daughters from five rams belonging to population Merino de Palas, 104 daughters from five rams of dairy population and 40 daughters from four rams of meat population.

The estimate of heritability was done by the method of *REML – Restrict Maximum Likelihood,* by which it is maximized only the segment from the function of maximum probability, which is invariant, compared to fixed effects.

Based on the systems of linear equations, additive genetic environment variances are obtained, due to dominance and epistasy, respectively:

$$V_M = \frac{P' \times P - \tilde{b} \times x' \times P - \hat{a}' \times P - \hat{a}' \times Z \times P - \hat{d}' \times Z \times P - \hat{i} \times Z \times P}{n-1(x)}$$

$$V_A = \frac{\hat{a}' \times A^{-1} \times \hat{a} + V_M \times tr(A^{-1} \times C_{22})}{q}$$

$$V_{D=} \frac{\hat{d}' \times D^{-1} \times \hat{d} + V_M \times tr(D^{-1} \times C_{33})}{q}$$

$$V_I = \frac{\hat{i}' \times H^{-1} \times \hat{i} + V_M \times tr(H^{-1} \times C_{44})}{q}$$

Where:

D represents the matrix of dominance relations among individuals, and H = *(A#A)* is the matrix of the relations due to epistasy. # is the Haddamard operator.

C_{22}, C_{33}, C_{44} are inverse elements of the equation system.

Finally, the heritability was estimated as the ratio between variation, additive genetics and total phenotypical variation, according to the relation:

$$h^2 = \frac{4 \times V_A}{V_P}$$

RESULTS AND DISCUSSION

I. Analysis of statistical indices (*Tables 1, 2, 3*)

In the case of Merino de Palas breed, the weight at birth was of 3.33 kg and at weaning the weight was of 53.01 kg. The wool yield was of 5.55 kg, the total milk yield of 390.25 kg and the number of lambs, of 1.45. The typical traits of the dynamics of body weight and wool population had a low or mean variability. The typical traits of the milk yield had a great variability, indicating the opportunity of continuous improvement of these traits by positive directional selection.

For the meat population created at the Research Station for Sheep Breeding of Palas, the analysis of indicators typical for the process of body development indicated lower values than in case of Merino de Palas breed. The average daily increase was of 170 g/day, with a great variability (VC = 33.1%), indicating the opportunity for this trait of being continuously improved. The variability was great too, in case of the body weight at birth, at weaning and at shearing. These traits could be improved by a strict selection.

In case of dairy population, the total milk yield was good (491 kg), for the first two milking periods being of 165 kg. In case of the third milking, it was of 159 kg. The variability of these traits is very high (VC% >50). The standard deviation being between 38-40 kg, it indicated the presence of plus and minus variants. For the improvement of these traits, their removal and the positive directional selection were necessary. Prolificacy was of 159%, being a sufficient prolific population.

2. Analysis of heritability coefficients (*Table 4*)

Heritability is the most important estimator as concerns the estimate of the weight of additive genetic variance, as well as of the environment. In case of populations with a high degree of homozygosis, higher values were registered in comparison with heterozygote populations, under conditions of the same traits.

Table 1

Statistical indicators for analysed productive characteristics in Merino de Palas breed

Trait	No of daughters	Statistical indicators				
		Mean and standard error of mean $\overline{X} \pm s_{\overline{x}}$	Standard deviation (s)	Variability coefficient (V%)	Minimum value	Maximum value
Weight at birth	71	3.33 ± 0.05	0.47	14.1	2.20	4.50
Weight at weaning	71	17.30 ± 0.41	3.45	19.9	6.50	25.00
Average daily increase	71	0.21 ± 0.00	0.04	19.3	0.13	0.30
Weight at shearing	71	53.01 ± 0.67	5.64	10.6	39.00	64.00
Wool yield	71	5.55 ± 0.10	0.90	16.2	4.00	8.00
Length of wool lock	71	8.55 ± 0.17	1.50	17.5	6.00	14.00
Finesse	71	22.38 ± 0.08	0.70	3.1	21.00	24.00
Waves	71	3.86 ± 0.08	0.68	17.6	3.00	5.00
Gloss	71	4.20 ± 0.05	0.46	11.1	3.00	5.00
Wool oil	71	7.89 ± 0.12	1.04	13.3	6.00	10.00
Total milk yield	71	390.25 ± 9.33	78.62	20.1	219.10	272.60
Milking 1	71	132.53 ± 4.51	38.04	28.7	62.50	279.50
Milking 2	71	130.09 ± 3.71	31.30	24.0	66.50	208.60
Milking 3	71	127.13 ± 415	34.98	27.5	60.20	257.90
No of lambs	71	1.46 ± 0.06	0.50	34.2	1.00	2.00

Table 2

Statistical indicators for the analysed productive characteristics of the milk yield

Trait	No of daughters	Statistical indicators				
		Mean and standard error of mean $\overline{X} \pm s_{\overline{x}}$	Standard deviation (s)	Variability coefficient (V%)	Minimum value	Maximum value
Weight at birth	104	3.22 ± 0.05	0.59	18.3	1.80	4.50
Weight at weaning	104	15.40 ± 0.31	3.25	21.1	9.00	23.50
Average daily increase	104	0.21 ± 0.00	0.05	24.6	0.10	0.34
Weight at shearing	104	37.77 ± 0.45	4.62	12.2	30.00	48.00
Wool yield	104	3.46 ± 0.07	0.78	22.7	2.20	5.50
Length of wool lock	104	13.73 ± 0.19	2.03	14.7	9.00	17.00
Finesse	104	25.49 ± 0.17	1.82	7.1	20.00	30.00
Gloss	104	3.92 ± 0.06	0.63	16.1	3.00	5.00
Wool oil	104	7.31 ± 0.12	1.22	16.7	5.00	9.00
Total milk yield	104	491.27 ± 8.1	82.72	16.3	318.10	705.80
Milking 1	104	165.99 ± 3.98	40.60	24.4	72.20	273.70
Milking 2	104	165.71 ± 3.61	36.83	22.2	107.30	330.30
Milking 3	104	159.49 ± 3.74	38.14	23.9	80.40	239.80
No of lambs	104	1.59 ± 0.04	0.49	31.9	1.00	2.00

Table 3

Statistical indicators for the analysed productive characteristics of the meat population

Trait	No of daughters	Statistical indicators				
		Mean and standard error of mean $\overline{X} \pm s_{\overline{x}}$	Standard deviation (s)	Variability coefficient (V%)	Minimum value	Maximum value
Weight at birth	40	3.15 ± 0.03	0.32	20.3	1.50	3.50
Weight at weaning	40	15.20 ± 0.59	3.76	24.7	7.50	25
Average daily increase	40	0.17 ± 0.00	0.05	33.1	0.07	0.36
Weight at shearing	40	47.58 ± 0.70	4.43	19.3	40.00	59.00
Wool yield	40	2.52 ± 0.10	0.67	26.3	1.20	4.00
Length of wool lock	40	5.74 ± 0.10	0.68	12.0	4.00	7.00
Finesse	40	22.13 ± 0.12	0.75	3.4	21.00	23.00
Waves	40	4.15 ± 0.11	0.70	16.8	3.00	5.00
Gloss	40	3.93 ± 0.13	0.82	21.1	3.00	5.00
Wool oil	40	7.58 ± 0.17	1.10	14.6	5.00	10.00
Total milk yield	40	356.52 ± 10.29	65.13	18.2	245.70	489.90
Milking 1	40	114.36 ± 4.5	28.77	52.1	74.50	212.60
Milking 2	40	123.24 ± 5.77	36.50	29.6	75.60	214.80
Milking 3	40	118.42 ± 4.71	29.82	25.1	60.50	184.00
No of lambs	40	1.53 ± 0.08	0.50	33.1	1.00	2.00

Table 4

Value of heritability coefficients for main analysed traits

Trait	h^2		
	Merino de Palas breed	Milk population	Meat population
Weight at birth	0.24	0.17	0.59
Weight at weaning	0.29	0.24	0.22
Weight at shearing	0.36	0.10	0.17
Average daily increase	0.39	0.24	0.31
Wool yield	0.52	0.12	0.18
Finesse	0.22	0.21	0.15
Waves	0.33	-	0.19
Gloss	0.34	0.36	0.09
Wool oil	0.30	0.46	0.31
Total milk yield	0.81	0.23	0.30
Milking 1	0.50	0.19	0.56
Milking 2	0.34	0.33	0.22
Milking 3	0.53	0.16	0.14

The analysis of the value of heritability coefficients represents an essential indicator on the evolution of animal populations, their breeding degree and genetic structural degree in the breeding process. The analysis of heritability was carried out in the case of the three sheep populations from the Palas Station, following the degree of genetic structure of these populations, for the analysed traits.

The analysis of the value of heritability coefficients pointed out:

- For the traits of body development, the values of heritability were mean ($h^2 = 0.2 – 0.45$), but constant in the dynamics of body development in the Merino de Palas breed, and variable in case of dairy and meat populations, indicating that they were not enough genetically structured;
- For the traits of wool yield in the Merino de Palas breed, the values of heritability were mean ($h^2 = 0.22$-0.5), and for the wool yield, too, h^2 being of 0.52, therefore a population with a strong and stable genetic determinism for this trait. In case of dairy and meat populations for the same category of traits, the values of heritability were lower than in case of Merino de Palas breed, with great variations in case of the same category of traits, pointing out the high values of variance for these traits;
- For the quantitative traits of the milk yield, higher heritability values were found in Merino de Palas breed. In case of dairy population, the heritability of total milk yield was of 0.23, with variations in the three studied milking periods from 0.16 to 0.33. The weak genetic structure of these traits was signalled. The genetic and environment variance was great, involving lower values of heritability and great variations from a milking period to another one.

CONCLUSIONS

The average values and the values of variability of body development traits and wool yield present an average variability in case of Merino de Palas breed and a great one, in case of the two populations. For the traits of milk quantitative yield, the variability is higher both in case of Merino de Palas and in dairy and meat populations.

The analysis of values of heritability coefficients, correlated to the variability of the same traits indicates the weak genetic structure of dairy and meat populations, for the main studied traits. For the traits created in the two populations, respectively, the traits typical of body development , of average daily increase and respectively, of milk yield, the values of heritability are lower than in case of Merino de Palas breed. There were great variations from one trait to another, within the same category of traits. It is necessary to continue the strict selection within the two populations, to diminish and stabilize the total phenotypical variability and the genetic variability, for the genetic structuring of these populations, as well as for increasing their phenotypical performance.

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