Weight development of sheep from the North-East Bulgarian Merino breed

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Abstract

The aim of the study was to assess the weight development of sheep from the North-East Bulgarian Merino breed, with a genetic component of the Australian Merinos (AM) and Booroola (Bo) breeds. Analyzed were 584 pedigrees and a total of 1002 records for live weight at weaning, at 9 and 18 months of ewes raised in the Scientific Center for Agriculture – Targovishte. An animal model was used to achieve this goal. The established average values for live weight were: 27.227 kg at weaning, 41.473 kg at 9 months and 51.111 kg at 18 months. The variation of the trait in all three ages was within 12%. Genetic estimates of the individual generations indicated a decrease in live weight at weaning and at 9 months. The phenotypic realization of the trait followed a clear negative tendency of the three ages. No genetic trend of dominance for live weight in purebred animals compared to animals with different participation of the AM breed in the genotype has been established. The genetic component of the Booroola breed has a lasting negative effect on the live weight of the studied ages.

Key words: live weight, additive and non-additive effects, North-East Bulgarian Merino Sheep, animal model

Introduction

In the early 90's, sheep from the Merino breeds were the most numerous population (1,541,000) in Bulgaria. The efforts of the research teams in this period were aimed at increasing the productivity and opportunities for improvement of sheep in this area both through purebred breeding and by including genetic components of the Australian Merino and Booroola breeds. In studies on the effect of applied methods and schemes of breeding, Boikovski (1995), Dimitrov (2001; 2006), Slavova (2000), Stefanova (2000), Slavov (2007), Slavov et al. (2008) found different variations, in relation to direction, in the values of the traits which were subject to selection.

Bulgaria's exit from the "closed eastern market" made the wool produced in the country uncompetitive compared to imported ones, and the subsequent economic reform reflected on the number of sheep of the Bulgarian Merino breeds to a degree of critical threat. The gene pool of this sheep population has been greatly altered, genetic structures have been disrupted, new, phenotypically similar, composite flocks and unified lines have been formed within which the breed combinations were in different proportions. Selection programs for their improvement have been replaced by programs for the conservation of the small number of animals left as a purebred part of the population. In 2011 a general "Breeding program of merino sheep in Bulgaria for the period 2011-2020" was adopted by the Association for breeding of Merino sheep in Bulgaria (ABMSB) (Stancheva et al., 2015, 2017). One of the main goals of the general Breeding program was the formation of intra-population structure of origins and genealogical lines, optimally combining several productivities – high live weight and wool yield, good quality indicators of wool and very good fertility (Boikovski et al., 2011). Live weight is a selection feature that is controlled in all productive areas, and the weight development of sheep is a key indicator for profitable production. This, in turn, requires the assessment of the effect of the selection to be based on information about the genetic changes in the structure of sheep from the Merino population.

The aim of the current research was to assess the weight development of sheep from the North-East Bulgarian Merino breed with genetic components of the Australian Merino and Booroola breeds.

Material and methods

The subject of the study was the weight development of sheep of the North-East Bulgarian Merino breed – Shumen type (NEBM). The animals were born in the period 2008–2012 and were bred in the Scientific Center of Agriculture – Targovishte, a branch of the Agricultural Academy system. To improve the quality of the wool and increase the fertility in the period 1984–1994 in the flock was introduced genetic plasma from the breeds Australian Merinos (AM) and Booroola (Bo). "In-line breeding" with rams of own production has been applied for more than 30 years.

The necessary data for the purpose of the study were provided by the Association for Breeding of Merino Sheep in Bulgaria.

Genetic structure of the flock

According to the information from the pedigree books, 584 pedigrees of 335 sheep were analyzed in relation to the breed type of parent and grandparents for each individual animal up to 3rd pedigree belt. The following scheme was used: ♀D(♀(DDDxSDD)x♂(DSDxSSD)) ♂S(♀(DDSxSDS)x♂(DSSxSSS)).

Based on the obtained information, it was found that the genetic structure in the studied flock was formed by 41 genotypes with different breed combinations. With complete pedigree data were 315 animals belonging to 33 genotypes, and in 20 individuals the origin of one of the direct parents has not been established. Depending on the percentage of individual breeds in the genotype of each individual, the genetic groups were also identified (Stanceva et al., 2017).

Genetic and phenotypic assessments. Estimates of additive genetic effects and non-additive abnormalities in identified genetic groups.

The study includes a total of 1002 records for live weight at weaning, at 9 and 18 months.

Based on the analyzed information about the breed of the parents and grandparents of each animal, a variable was generated with the individual information about the genetic origin of each animal. This allowed the correct reflection of alleles coming from different populations on the paternal or maternal line for the genotype of each animal.

A model based on the general genetic hypothesis was used to establish unbiased assessments. The analysis was based on the theoretical expectation that the genetic variation in the studied population was caused by both the additive effect of individuals and non-additive effects caused by variation in different genotypes of individuals resulting from the interaction between breeds involved in the formation of pedigree of each animal. The analysis of the genetic effects in the identified genetic groups was performed in two stages – assessed components of the genotypes and genetic effect of the genetic groups.

The statistical analysis was based on an animal model from the following type:

$$Trait_{ijklm} = Year_j + Gen_j + Animal_k + E_{ijklm}$$

Where:

Trait – m studied trait;

$Year_i$ – fixed effect of I year;

Gen_j – random effect of j genotype;

$Animal_k$ – random effect of k animal;

E_{ijklm} – random effect of unsupervised factors;

The VCE software by Kovac et al. (2008) and PEST by Groeneveld et al. (2002) were used for the calculation of the results.

Results and discussion

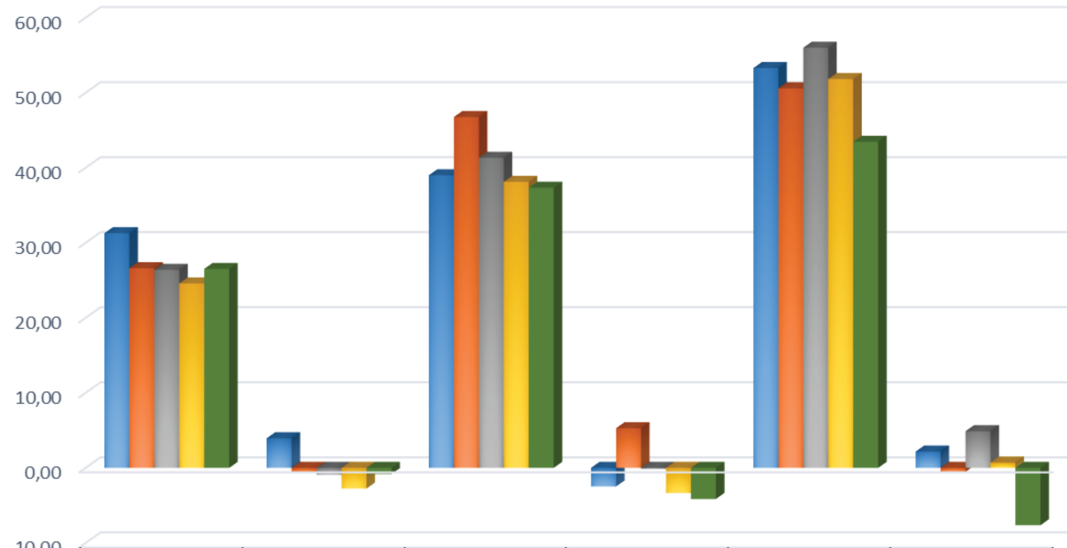
The results for the weight development of ewes are shown in Table 1. The average values for live weight at weaning were 27.227 kg, 41.473 kg at 9 months and 51.111 kg at 18 and the variation of the trait at all three ages was within 12%. In a study on the weight development of sheep born in 1995–2002 from the same flock, Dimitrov (2006) obtained close to our values for live weight at weaning (27.039 kg), lower for the weight at 9 months (39.083 kg) and significantly higher value of the trait at 18 months (55.336 kg). In a subsequent study, Staikova and Stancheva (2009) found a lower than our value for live weight at weaning (26.856 kg), but significantly higher values for the trait at 9 and 18 months (51.395 kg and 60.727 kg respectively). The results reported by Tzonev (2014) for weight development of sheep from the Merino population were close to the live weight at weaning (27.53 kg) and higher at the following ages – 42.77 kg at 9 months and 53.96 kg at 18 months. For the flock studied by us, the values reported by the same author for weight development of animals in 2007–2011 were lower at all studied ages (24.8 kg and 24.0 kg at weaning; 32.4 kg and 38.5 kg at 9 months; 43.1 kg and 46.7 kg at 18 months). For the 18-month-olds from the Bulgarian Merino breeds Stancheva et al. (2015) reported values for live weight from 51.5 kg to 53.4 kg in 2012 and from 46.8 kg to 53.0 kg in 2013. As for the 18-month-old animals from the studied flock the values of live weight were higher than ours in 2012 and significantly lower in the following year (51.5 kg and 46.8 kg). In the reports of the Association for Breeding Merino Sheep in Bulgaria (2017; 2018), the average values of the trait for sheep from the Merino population in the country in 2017 were 26.660 kg at weaning, 41.415 kg at 9 months and 56.762 kg at 18 months, and in 2018 it was reported higher live weight at weaning (29.20 kg) and at 9 months (44.63 kg) and a significant decrease in weight at 18 months (52.69 kg). The values for live weight of sheep of NEBM breed (Shumen type) were higher than ours at weaning (27.941 and 32.41 kg) and at 18 months (64.738 and 57.66 kg) while at 9 months the live weight had lower values in 2017 and higher in 2018 (38.330 and 50.05 kg).

Live weight is known to be influenced by genetic and non-genetic factors (Mandal et al., 2003; Behzadi et al., 2007; Dass et al., 2008; Rashidi et al., 2008; Petrović et al., 2012; Taskin et al., 2012; Momoh et al., 2013). The dynamics of the trait in the course of the selection process is of undeniable interest. In our country, Stefanova (2000); Dimitrov (2001, 2006); Slavov (2007); Staikova and Stancheva (2009); Tsonev (2014) found a reliable effect of the year of birth, year of production and other factors on the weight development of sheep of NEBM breed.

The estimates of the individual generations for live weight are reflected in Figure 1. There is a tendency for a decrease in live weight at weaning and at 9 months. Only animals born in 2008 (31.278 kg) and those born in 2009 at 9 months (46.754 kg) have an estimate above the total average and with positive deviations of the first age. At 18 months of age, estimates were mixed and did not show a clear tendency to increase or decrease live weight.

Table 1. General mean of the live weght of North-East Bulgarian Merino Sheep, kg

Live weight	observations (n)	χ	C.V. (%)	S.D.
at weaning	335	27.337	12	3.375
on 9 months of age	334	41.473	12	4.841
on 18 months of age	333	51.111	12	6.101



	at weaning	deviation	at 9 months	deviation	at 18 months	deviation
2008	31,278	3,941	38,998	-2,475	53,281	2,170
2009	26,608	-0,729	46,754	5,281	50,578	-0,533
2010	26,393	-0,944	41,316	-0,157	55,993	4,882
2011	24,580	-2,757	38,115	-3,358	51,812	0,701
2012	26,513	-0,824	37,327	-4,146	43,462	-7,649

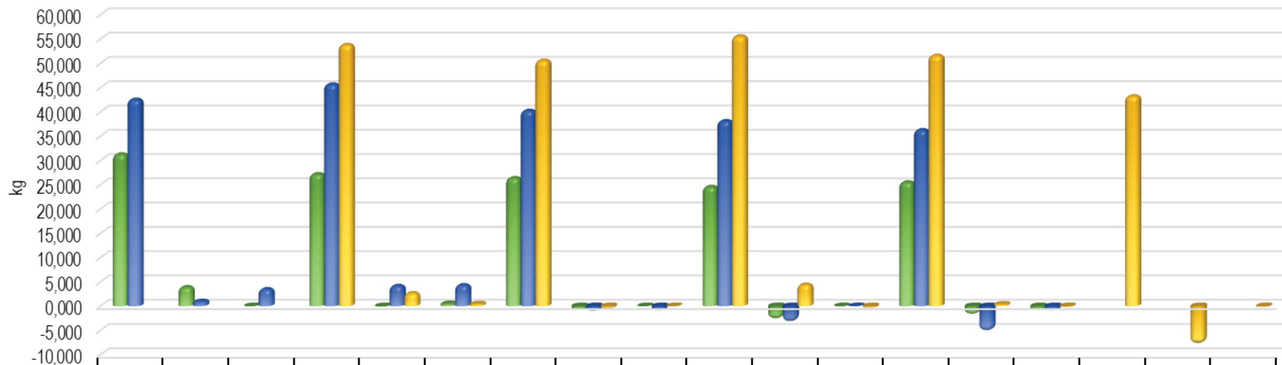
Fig. 1. Estimates of weight development depending on the wear of birth, kg

Those with the highest assessments and positive deviations were those born in 2010 (55.993 kg), followed by those born in 2008 and 2011 (53.281 and 51.812 kg). Sheep born in 2012 had estimates below the general average of all ages. The compensatory abilities of the animals were best expressed in the generations from 2010 and 2011, for which the estimates for live weight at weaning were the lowest, below the total average at 9 months and were above the total average at 18 months of age.

Figure 2 shows the phenotypic realization of live weight for different ages. The results again confirmed our thesis that the manifestation of the genetic abilities of animals was largely due to changes in environmental factors in the years of production. In the marketing year 2008 the realized live weight at weaning was within the genetic potential of the animals and significantly exceeded it at 9 months (0.000 and 3.535). The deviations of the trait from the general average of the two ages (3.941 and 1.060) were also positive.

The observed dynamics of change in the values of the trait was probably due to both the conducted breeding activity and to the care taken for the breeding and feeding of the animals during the separate economic years. Figure 2 shows the phenotypic realization of live weight for different ages. The results again confirmed our thesis that the manifestation of the genetic abilities of animals was largely due to changes in environmental factors in the years of production. In the marketing year 2008 the realized live weight at weaning was within the genetic potential of the animals and significantly exceeded it at 9 months (0.000 and 3.535). The deviations of the trait from the general average of the two ages (3.941 and 1.060) were also positive.

The phenotypic realization of live weight was above the abilities of the animals of the three studied ages in the next 2009 marketing year (0.587 at weaning, 4.351 at 9 months and 0.514 at 18 months). Deviations from the general average were negative at weaning and positive at the next two ages. The results for weight development in



	2008	deviation from the average	deviation from genetic mean	2009	deviation from the average	deviation from genetic mean	2010	deviation from the average	deviation from genetic mean	2011	deviation from the average	deviation from genetic mean	2012	deviation from the average	deviation from genetic mean	2013	deviation from the average	deviation from genetic mean
at weaning	31,278	3,941	0,000	27,195	-0,142	0,587	26,393	-0,944	0,000	24,580	-2,757	0,000	25,520	-1,817	-0,993			
at 9 months	42,533	1,060	3,535	45,667	4,194	4,351	40,244	-1,129	-1,072	38,120	-3,353	0,005	36,257	-5,216	-1,070			
at 18 months				53,795	2,684	0,514	50,566	-0,545	-0,012	55,555	4,444	-0,438	51,562	0,451	-0,250	43,236	-7,875	-0,226

Fig. 2. Phenotipic assessment of realized live weight

the following economic years were mostly negative and worrying. The differences in live weight at weaning could be explained by the presence of a maternal effect and probably the admission of replacement lambs with lower live weight and lower age by the breeder, but the subsequent weight development of the animals was, in our opinion, an indicator of that there were serious shortcomings in their cultivation and balanced nutrition.

In studies on the influence of blood pressure from AM on the weight development of sheep from NEBM breed and the Thracian Merino breed, Stefanova (2000) and Slavova (2000) did not find a significant influence on the trait. In subsequent studies on the effect of the introduced genetic components of the Australian merino and Booroola breeds on the weight development of sheep of both types of NEBM breeds, Dimitrov (2001, 2006) and Slavov (2007) also found that AM blood flow had no significant effect while Booroola breed had a negative effect on the trait.

The summarized assessments of the genetic effects in the identified genetic groups are shown in Table 2. The results show that in the conditions of internal breeding purebred animals of NEBM breed have completely negative deviations for the additive and non-additive epistatic effect of the three studied ages (27.206 and -0.131 for live weight at weaning; 41.249 and -0.224 for live weight at 9 months; 50.659 and -0.452 for live weight at 18 months).

The results are different for ewes with a genetic component of the AM breed. The deviations for the additive and non-additive epistatic effect of the genetic group with 12.5% participation of the AM breed were negative at weaning and 9 months, and positive ones at 18 months (27.028 and -0.309 for live weight at weaning; 40.704 and -0.769 for live weight at 9 months; 51.951 and +0.840 for live weight at 18 months). With entirely positive deviations for the additive and non-additive epistatic effect were individuals with 25% genetic component of the AM breed (27.561 and +0,224 for live weight at weaning; 42.339 and +0.866 for live weight at 9 months; 51.153 and +0.042 for live weight at 18 months). There were positive deviations for the additive and non-additive epistatic effect of the genetic group with 37.5% participation of the AM breed at weaning and 9 months, and negative ones at 18 months (27.923 and +0.586 for live weight at weaning; 41.059 and +0.327 for live weight at 9 months; 50.918 and -0.193 for live weight at 18 months). With completely negative deviations for the additive and non-additive epistatic effect were the individuals from the genetic group

Table 2. Estimation of the genetic effects of the different genetic groups

Genetic group	n	At weaning, kg		At 9 months of age, kg		At 18 months of age, kg	
		Group additive means	non-additive variance	Group additive means	non-additive variance	Group additive means	non-additive variance
100% NEBM	68	27.206	-0.131	41.249	-0.224	50.659	-0.452
87.5% NEBM 12.5%,AM	35	27.028	-0.309	40.704	-0.769	51.951	0.840
75% NEBM 25% AM	70	27.561	0.224	42.339	0.866	51.153	0.042
62.5% NEBM 37.5% AM	56	27.923	0.586	41.059	0.327	50.918	-0.193
50% NEBM 50% AM	37	27.062	-0.275	40.573	-0.900	50.950	-0.521
62.5% NEBM 37.5% Bo	14	26.892	-0.445	40.022	-1.451	49.582	-1.529
50% NEBM 50% Bo	8	26.319	-1.018	42.007	0.534	50.710	-0.401
75% NEBM 12.5% AM 12.5% Bo	8	27.996	0.659	41.998	0.525	50.285	-0.826
62.5% NEBM 25% AM 12.5% Bo	5	24.963	-2.374	38.,217	-3.256	49.988	-1.123
62.5% NEBM 25% Bo 12.5% AM	5	25.808	-1.529	40.392	-1.081	50.725	-0.386
50% NEBM 37.5% Bo 12.5% AM	3	31.436	4.099	43.657	2.184	50.313	-0.798
50% NEBM 25% AM 25% Bo	3	27.292	-0.045	43.239	1.766	57.359	6.248
87.5% NEBM 12.5% Bo	2	25.916	-0.948	40.635	-0.559	44.436	-4.450
50% NEBM37.5% AM 12.5% Bo	1	28.157	0.820	48.951	7.478	51.373	0.262
Unknown pedigree from the side of one of the parents	20	26.773	-0.564	41.932	0.459	53.704	2.593

50% NEBM 50% AM (27.062 and -0.275 for live weight at weaning; 40.573 and -0.900 for live weight at 9 months; 50.950 and -0.521 for live weight at 18 months).

In the two groups with different genetic component of the Booroola breed, the values of the additive and epistatic non-additive effect were negative at all ages. Exceptions were the established positive values for live weight at 9 months for animals with 50% participation of the Booroola breed.

The inclusion of the three breeds in breeding schemes did not show good combinatorial ability. The values of the additive and epistatic effect were below the general average and with negative deviations for the more significantly presented genetic groups. Exceptions were animals from the genetic group 75% NEBM 12.5% AM 12.5% Bo, in which there was a certain excess of live weight at weaning and at 9 months (27.996 and 41.998) and positive non-additive deviations (+0.659 and +0.525). Similar results were observed in some single individuals with the participation of the three breeds, but their small number and the lack of data on the manifestation of the trait of the following ages did not give grounds for definite statements. It is possible that the positive values were due to random genetic interactions and favorable environmental factors.

For the group of animals of unknown origin in one of the direct parents, the mean values for the additive and epistatic effect were negative at weaning and positive at the following ages.

Our results confirmed the thesis of Slavova (2000), Stefanova (2000), Dimitrov (2001) and Slavov (2007) that the introduced genetic component of the AM breed did not have a significant impact on the weight development of sheep from NEBM breed. The negative effect of the Booroola breed on the live weight of sheep, established by Dimitrov (2001) and Slavov (2007), was also confirmed.

In summary, we can say that the internal breeding of NEBM breed does not establish a genetic trend of dominance in purebred animals of NEBM breed in terms of weight development of sheep compared to animals with different participation of the AM breed. There is a certain positive effect, which is most pronounced in individuals from the genetic group 75% NEBM 25% AM. With regard to the Booroola breed, a lasting negative effect on the live weight of the studied ages was established.

Conclusions

Genetic estimates of the individual generations indicated a decrease in live weight at weaning and at 9 months. There was a clear negative tendency for the phenotypic realization of the trait of all ages.

No genetic trend of dominance for live weight in purebred animals compared to animals with different participation of the AM breed in the genotype has been established. There was a certain positive effect, which was most pronounced in individuals from the genetic group 75% NEBM 25% AM.

The genetic potential of the Booroola breed had a long-lasting negative effect on live weight in all studied ages.

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