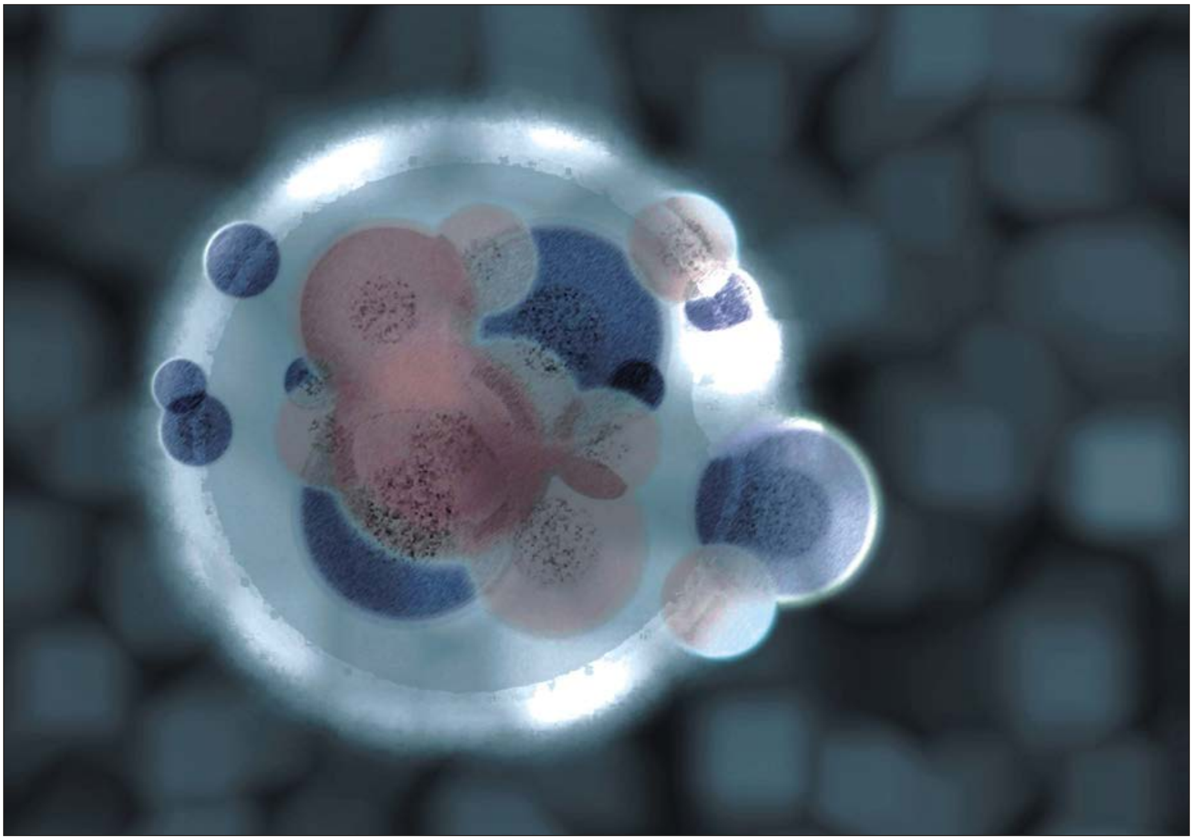

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Phenotypic and Genetic Parameters for Litter Size in Some Regional Synthetic Sheep Genotypes: Evidence for a Major Gene Effect

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Abstract: The objective of the present study were to estimate the some phenotypic and genetic parameters of litter size in some regional sheep populations consist of three sheep genotypes of Aydin province; synthetic Karya Type, regional Kivircik and unpurebred Cine Capari. Litter size data of 344 ewes (1090 observations) were collected from eight flocks maintained at the rural farms. The least square means of litter size were 1.61±0.119, 1.36±0.089, 1.20±0.066 and 1.39±0.057 for four Karya Type flocks, 1.10±0.047, 1.08±0.070 and 1.21±0.092 for three regional Kivircik flocks and 1.00±0.068 for one unpurebred Cine Capari flock. Repeatabilities for litter size were 0.61±0.08, 0.63±0.05, 0.62±0.07 and 0.59±0.07 for four Karya Type flocks, 0.62±0.07, 0.54±0.09 and 0.20±0.19 for three regional Kivircik flocks and 0.50±0.07 for one unpurebred Cine Capari flock. The heritability estimations were found 0.74±0.07 from regression of corrected mean litter size of ewes on corrected means of their dams and 0.56±0.21 from the regression of breeding values of litter size of ewes on the breeding values of her dams. Results indicate that the large part of observed variation in the regional synthetic sheep types were genetic, possibly caused by a major gene segregating at low frequencies.

Key words: Sheep, litter size, repeatability, heritability, major gene

INTRODUCTION

Turkey is one of the leading sheep raising countries of the world. Although most of the local breeds are low productive, they are well adopted to the poor feeding and management conditions. There are no breed societies, flock books or field recording systems. The majority of the Turkish native sheep consists of the fat-tailed breeds. Thin-tailed sheep breeds (Kivircik breed and new types) are generally raised on the seacoast of western Anatolia (Sonmez, 1994).

Cine Capari has been known as the fat-tailed regional rare sheep breed in mountainous region of Aydin province. But, in the last two decade, this breed has been gradually backcrossed with prolific Chios (locally known as Sakiz), Kivircik or Chios x Kivircik rams. Chios breed has a great importance for the crossing efforts of breeders due to their superior prolificacy. Number of purebred Cine Capari was very declined due to intense backcrossing. Two synthetic sheep genotypes (Karya Type and regional Kivircik) was formed as a result of unsystematically crossing and inefficient selection works by breeders to increase prolificacy and dairy abilities of ewes. Karya Type sheep was formed from backcrossing of Cine Capari with Kivircik and Chios rams (each contributing approximately 50%). This genotype is very suitable for lowland management conditions that better than fully extensive. A Karya Type sheep is a very small-tailed and white coloured with black marks on the head and legs. On the other hand, regional Kivircik was formed for relatively bad pasture conditions of hills by intense backcrossing of Cine Capari with Kivircik rams. A regional Kivircik sheep is thin-tailed and white color. It is more probable to find hyper prolific ewes or families in Karya Type and regional Kivircik sheep flocks. This phenomenon may be due to existence of major gene originated probably from prolific Chios breed.

Despite of polygenic nature of the prolificacy, several genes having a major effect on trait have been identified in some sheep breeds in recent years. The first of these major genes, Fec^B gene, was identified in Booroola Merino (Davis *et al*., 1982; Piper and Bindon, 1982). The discovery of the Booroola gene has generated considerable interest among sheep breeders and scientists. After the discovery of the Booroola gene in the Merino sheep, segregation of similar genes affecting prolificacy has been described or postulated in several other sheep populations, such as Icelandic, Cambridge,

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Javanese, New Zealand Romney, Olkuska, Belclare, Creole, Lacaune (Owen and Ap-Dewi, 1988; Mahieu *et al*., 1989; Bradford *et al*., 1991; Davis *et al*., 1991; Hanrahan, 1991; Jónmundsson *et al*., 1991; Martyniuk and Radomska, 1991; Lecerf *et al*., 2002).

Attempts to improve litter size by selection within a breed result in slow progress because the heritability of litter size is quite low (Bradford *et al*., 1991; Fogarty, 1995). Therefore the application of selection directly on genotypes or phenotypes for the major locus allows more rapid improvement in the short term (Karaca *et al*., 1992; Cemal, 1996).

The aims of this study were to estimate phenotypic and genetic parameters for litter size in newly formed synthetic sheep genotypes of Aydin region and to describe genetics of high litter size observations in some flocks or families. The main characteristics of newly developed sheep genotypes have not been studied previously. Therefore, this pre-study has a great importance for the future works.

MATERIALS AND METHODS

Source of data: The litter size data analyzed in this paper were collected from different synthetic sheep flocks maintained at rural farms in Cine county of Aydin province. The synthetic sheep genotypes were Karya Type, regional Kivircik and unpurebred fat-tailed Cine Capari. Flocks were managed in extensive conditions and sheep were kept on unimproved pastures throughout the year. Ewes do not received supplementary feed during the mating season. Average flock size is approximately 53 (varying from 34 to 86) and each flock has one ram and used it for 2 or 3 years. Therefore, flock and sire effects overlapped and considered together in analysis. The litter size data (1090 records of 344 ewes) were collected from 8 rural farms during 4-year period (1993-96). Furthermore, litter size performances of dams of ewes were obtained from breeders and based on their memory. The validity of data that based on memory of sheep breeders was checked with cross-examinations.

Statistical Analyses: Observed litter size of ewes and breeders knowledge about litter size of dams was statistically analyzed according to the following models. Model used for analyzing all flocks together was:

$$Y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$$

Model used for analyzing each flock separately:

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk}$$

where:

Y_{ijkl} and Y_{ijk}	=	Variables being analyzed;
μ	=	Overall mean;
a_i	=	ith ewe age (I = 2,3,...,8);
b_j	=	jth year period (j = 1992-93, 1993-94, 1994-95 and 1995-96);
c_k	=	kth flock (k = 1,2,...,8);
e_{ijkl} and e_{ijk}	=	Random error terms.

The repeatability of litter size for each flock was estimated by Restricted Maximum Likelihood (REML). Litter size data of sheep that have more than one lambing record were used for repeatability estimations. The heritability of this trait were estimated from two data type by offspring-parent regression. Firstly, from regression of corrected mean litter size of ewes on corrected means of their dams, secondly, from the regression of breeding values of litter size of ewes on the breeding values of her dams. Breeding values were estimated only for ewes that have two or more performance records. The coefficient of variation (CV) for litter size were estimated for each flock separately.

The General Linear Models of SAS (1999) were used in the initial analyses of the data to determine the contribution of fixed effects on litter size of ewes. Genetic parameters were estimated by Mixed Model Least-Squares and Maximum Likelihood Program (LSMLMW) of Harvey (1990).

RESULTS AND DISCUSSION

Least squares means with standard errors for fixed effects of ewe age and birth year on litter size in different sheep flocks were summarized in Table 1. Only in Flock 1 the effect of ewe age on litter size was significant ($p<0.01$) but in all other flocks ewe age and year effects were not significant ($p>0.05$). Mean litter size of flocks of Karya Type sheep were generally higher than flocks of regional Kivircik and unpurebred Cine Capari genotypes. The more probable source of this difference is the prolific Chios breed used in formation of synthetic Karya Type.

Repeatability and coefficient of variation (CV) estimates of litter size in three synthetic sheep genotypes are presented in Table 2. Repeatability estimates of all flocks except flock 7 were equal or higher than 0.50. Repeatabilities of all four Karya Type sheep flocks are similar and higher than another flocks. There are no connections between the level of mean litter size and repeatability estimations for flocks.

Table 1: Least-squares means (±SE) for fixed effects of ewe age and birth year on litter size in different sheep flocks

	Flock 1 (KT)		Flock 2 (KT)		Flock 3 (KT)		Flock 4 (KT)	
Factors	N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE
Ewe age		p<0.01		NS		NS		NS
2	20	1.13±0.127	11	1.28±0.170	30	1.12±0.070	16	1.51±0.127
3	33	1.12±0.096	24	1.40±0.122	42	1.18±0.057	35	1.51±0.091
4	29	1.28±0.102	24	1.31±0.111	31	1.20±0.067	34	1.44±0.083
5	24	1.44±0.127	27	1.39±0.108	21	1.23±0.090	49	1.36±0.072
6	14	1.58±0.171	26	1.38±0.129	15	1.33±0.117	44	1.26±0.085
7	4	2.36±0.344	15	1.35±0.173	7	1.18±0.160	27	1.21±0.113
8	-	-	7	1.42±0.239	-	-	20	1.41±0.144
Birth year		NS		NS		NS		NS
1993	22	1.78±0.188	27	1.29±0.147	20	1.25±0.114	48	1.35±0.093
1994	29	1.68±0.150	31	1.48±0.118	28	1.23±0.088	53	1.38±0.077
1995	36	1.53±0.117	38	1.37±0.099	49	1.16±0.065	62	1.44±0.069
1996	37	1.45±0.107	38	1.30±0.104	49	1.18±0.056	62	1.38±0.078
Overall	124	1.61±0.119	134	1.36±0.089	146	1.20±0.066	225	1.39±0.057

NS: Non significant (p>0.05), KT: Karya Type

Table 1: Continued

	Flock 5 (RK)		Flock 6 (RK)		Flock 7 (RK)		Flock 8 (UCC) Factors	
Factors	N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE
Ewe age		NS		NS		NS		NS
2	47	1.20±0.052	21	1.17±0.070	32	1.14±0.058	5	1.05±0.132
3	50	1.19±0.050	14	1.08±0.080	36	1.11±0.054	20	1.15±0.090
4	38	1.09±0.065	11	1.30±0.092	25	1.01±0.076	23	1.13±0.070
5	21	1.03±0.091	5	1.25±0.214	14	0.97±0.110	31	1.13±0.059
6	11	0.99±0.123	-	-	5	0.76±0.163	28	1.05±0.071
7	3	0.97±0.190	-	-	-	-	12	1.11±0.104
8	-	-	-	-	-	-	9	1.05±0.133
Birth year		NS		NS		NS		NS
1993	20	1.04±0.116	2	1.54±0.204	14	0.84±0.126	29	1.09±0.086
1994	39	1.08±0.088	9	1.12±0.114	24	0.90±0.091	32	1.11±0.066
1995	51	1.07±0.066	14	1.14±0.093	36	1.04±0.064	32	1.07±0.064
1996	60	1.13±0.051	26	1.06±0.076	38	1.21±0.052	35	1.12±0.067
Overall	170	1.08±0.070	51	1.21±0.092	112	1.00±0.068	128	1.10±0.047

NS: Non significant (p>0.05), RK: Regional Kivircik, UCC: Unpurebred Cine Capari

Table 2: Repeatability (±SE) and coefficient of variation (CV) estimates for litter size

Flocks	Genotypes	No ewes	No records	CV	Repeatability±SE
1	Karya Type	36	124	26.66	0.63± 0.08
2	Karya Type	38	134	26.15	0.63± 0.05
3	Karya Type	49	146	20.05	0.62± 0.07
4	Karya Type	62	225	23.97	0.59± 0.07
5	Regional Kivircik	61	170	19.41	0.62± 0.07
6	Regional Kivircik	26	51	20.69	0.20± 0.19
7	Regional Kivircik	38	112	19.23	0.54± 0.09
8	Unpurebred Cine Capari	34	128	20.17	0.50± 0.07

Table 3: Estimates of heritability for litter size of sheep from two data type

Type of data*	No. of records	h^2±SE
1	691	0.74± 0.07
2	80	0.56± 0.21

* 1: Regression of corrected mean litter size of ewes on corrected means of their dams, 2: Regression of breeding values of litter size of ewes on the breeding values of her dams

Table 3 shows the heritability estimates of litter size from two different approaches. Heritabilities estimated from regression of corrected mean litter size of ewes on corrected means of their dams and from the regression of breeding values of litter size of ewes on the breeding values of her dams are high and moderate, respectively.

The results of several studies on repeatability and heritability estimates of litter size in sheep were summarized elsewhere (Bindon and Piper, 1979; Fogarty, 1995). Similar results were reported for prolific sheep breeds (Fahmy, 1996; Hatziminaoglou *et al*., 1996; Maijala, 1996). It is clear that repeatability and heritability of litter size in sheep is quite low. But the repeatability and heritability of litter size obtained in present study are extremely higher than parameters reported in the literature for various sheep breeds. The observation of high values of repeatability and heritability may be first indicators of the segregation of a major gene (Le Roy and Elsen, 1991 and 1992; Cemal *et al*., 1996; Mulsant and Elsen, 1996; Cemal, 2001).

CONCLUSIONS

Results suggested that the large part of observed variation in the regional synthetic sheep genotypes was genetic, possibly caused by segregation of a major gene originated from Chios breed. The efficiency of classical selection programs can be improved by the use of major gene information. For this reason, it is of great interests to detect such genes and genotyping individuals. Detection of major genes or QTL has been more possible with the advances of molecular genetics and statistical methods in the last years. Further detailed experimental designs and statistical tools is required to confirm the existence of a major gene and to detect genotype of individuals.

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