



Estimation of environmental effects on test day milk yield in Patch-faced Maritza sheep

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Abstract. *The aim of this study was to estimate environmental effects on test day milk yield (TDMY) in Patch-faced Maritza sheep breed. Database includes 12 955 milk yield records in the test day. Milk yield recordings were made in 18 flocks and test day milk yields were obtained from 1992 to 2015 (24 years). In the structuring of the database, the following environmental effects were differentiated: animal; flock; year-season of lambing effect (YS); parity effect (Par); litter size at birth (LS); age of ewe at lambing (AgeL); age of ewe at test day (AgeTD); suckling period (Suck); ewe test day (ETD); flock test day (FTD); flock-year-test day (FYTD); stage of lactation period (DIM); stage of lactation period defined at 3-day intervals (DIM3). Average TDMY was 748.59 ± 416.22 mL. The highest test day milk yield was in the first test day of ewes (1015.80 ± 457.67 mL) and gradually decreased to seventh test day (267.50 ± 120.05 mL). All mentioned environmental effects have influence on TDMY and have significant effect ($p < 0.001$). The FYTD had the largest proportion (41.57%) on the total phenotypic variation. A large part of the total phenotypic variation had the following effects: Animal (31.11%), AgeTD (30.95%), DIM (27.85%), DIM3 (27.14%) and ETD (21.92%). Considering the significant influence of the described environmental effects on the TDMY in the population of Patch-faced Maritza sheep breed, they should be taken into account when estimating the genetic parameters.*

Keywords: test day milk yield, environmental effects, Patch-faced Maritza sheep breed

Introduction

Due to the high demand for sheep milk, as a raw material for the production of cheese and other dairy products, there is an increasing interest in dairy sheep breeds as well as in native Bulgarian sheep breeds with good milk yield. In the last decade, the milk yield of sheep breeds has been set as an important trait in the breeding program of perspective sheep breeds in Bulgaria.

Analyzing the breeding programs of some sheep breeds in the Mediterranean countries, Sanna et al. (2002) consider that the main environmental effects that affect milk yield in sheep are: milking length, flock-year, age of lambing, month or lambing season, interval between lambing, number of lambs born or weaned.

Usually, when analyzing the milk yield data in sheep,

many authors take into account the effects of year, flock, parity, month of lambing, litter size, on test day milk yield (Oravcová et al., 2005; Oravcová et al., 2006; Bauer et al., 2012). Analyzing environmental effects on test day milk yields of Sarda dairy ewes in addition of factors listed above Macciotta et al. (1999) take into account also altitude at which sheep farms are located (plains, hills and mountains).

In connection with the use of more complex models for estimations of genetic parameters and breeding values (repeatability models and random regression models) many authors describe the influence of the environment by adding differently the influence of the stage of lactation (DIM factor) or combine two or three environmental factors in one - flock-year, flock-year-month, flock-year-season, year-season (Ruiz et al., 2000; Riggio et al.,

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2007; Komprej et al., 2011). This is done especially in unbalanced database (Oravcová et al., 2006).

Patch-faced Maritza sheep is a dual-purpose breed for milk and meat, typical for lowlands, and in recent years the breed has spread to some semi-mountainous regions. Good milk yield and prolificacy (Dimov, 1998) and also high live weight (Dimov et al., 2015) make this sheep breed competitive among other native breeds in the country.

For years, the selection of Patch-faced Maritza sheep breed for milk yield has been based on phenotype values of dams and environmental effects were not taken into account. The new breeding programme for this breed aims to use test day models for estimation of genetic parameters and breeding values and therefore this requires the inclusion of many environmental and other non-genetic effects.

The aim of this study was to estimate systematic environmental effects on test day milk yield (TDMY) from the point of view of their use in test day models for estimating genetic parameters and breeding values.

Material and methods

The farming systems in which native sheep breeds in Bulgaria suitable for milk production are kept, usually have some typical features. In all flocks there is suckling period of two or three months and milking of the sheep is manual. Furthermore, during winter period (around 5 months) the flocks are kept indoor. The feeding is predominantly with alfalfa hay and straw combined with grain (corn and barley). The grazing period lasts around 7 months. Usually, the farmers use common pastures combined with post-harvest cereal waste.

The data used for this analysis were provided by the Breeding association of native Maritza sheep breeds. Ewes of different ages are bred in all flocks of the Patch-faced Maritza sheep breed and there are no flocks formed by age.

For the purposes of this study, a test day milk yield database was structured. Twelve thousand nine hundred and fifty-five milk yield records for 1382 ewes have been included in the database. Milk recordings were organized in accordance to ICAR (ICAR regulations - Barillet et al., 1992) rules for the AC method. The rule for coverage of the maximum part of the milking period, regardless of its duration, has been complied during the test day records over the years. As noted above, in the majority of the flocks, there is a long lambing campaign. After completing milk recording in milking period in the flocks of Patch-faced Maritza sheep, different ewes have a different number of test days per lactation from 3 to 7.

Data on test day milk yields were obtained from 1992 to 2015 (24 years). Milk yield recordings were made in 18 flocks which were located in Plovdiv region. The number of flocks in which milk recordings lasted more than 10 years is too small – only 4 flocks. Milk recordings in some flocks are usually maintained as a regular practice for 3 to 5 years. There were also several flocks in which the procedure for measuring milk yield was carried out for only 1 or 2 years.

Some limitations in the database were made before the data were processed. The database included ewes with test day milk yield from 100 to 4000 mL, with suckling period of 30 to 150 days, with minimum of 3 test day records per milking period. The number of born lambs was described as fix effect with 2 levels (1 and 2 born lambs). Due to the relatively small number of cases of ewes with triplets, they were included in the group of 2 lambs.

Due to the long lambing campaign over the years, in order to take into account this effect, the lambing season was divided into 3 levels. The first level included ewes that lambed in August, September, October and November. On the second level were included ewes that lambed in December, January or February. In the third level were included ewes that lambed in March, April, May and June. Thus, the seasonal effect was formulated, which was combined with the effect of the year and the „year-season“ effect was obtained.

The comparatively long period (24 years), in which the data from the milk recordings were accumulated and the short period of the continuity of breeding activity in the individual farmers – 4.99 years (Zhelyazkova et al., 2018), necessitated the concatenation of the factors flock-year-test day (FYTD).

The choice of environmental effects on milk yield was borrowed from other authors in the available literature (Oravcová et al., 2005; Oravcová et al., 2006; Komprej et al., 2009; Komprej et al., 2013; Macciota et al., 1999).

Statistical analysis was performed by using the GLM procedure of the SPSS 19.0 for Windows (IBM, 2009).

Results and discussion

Means and standard deviations in TDMY, age in lambing date, suckling period and litter size of Patch-faced Maritza sheep breed are given in Table 1. Average TDMY was 748.59 mL. The range of variation was wide, from 100 to 4000 mL. The coefficient of variation of TDMY was relatively high - 56%. As expected, average TDMY of Patch Faced Maritza sheep – 748.59 mL was lower than TDMY of specialized dairy sheep breeds as East Frisian - 2.33 kg (Hamann et al., 2004), Asaf (Spanish) - 1660

mL (Gutierrez et al., 2007), Lacaune dairy sheep - 1820 mL (Hernandez et al., 2011), Valle del Belice - 1167 g (Riggio et al., 2007), Churra - 956 mL (Othmane et al., 2002), Sfakia dairy ewes - 0.86 kg (Volanis et al., 2002), Bulgarian dairy synthetic population - 0.896 L (Krastanov et al., 2018). Compared to the East Frisian sheep breed - 2.09 (Hamann et al., 2004), the litter size at birth was also lower - 1.37. Earlier studies on the litter size of Patch-faced Maritza sheep breed for the period 1991 - 1999 was size - 1.546 (Dimov, 2000), and for the period 2002 - 2005 Vuchkov (2009) found out litter size - 1.36. Zhelyazkova et al. (2014) reported that litter size of the Bulgarian dairy synthetic population sheep around Plovdiv region for the period 2006 - 2009 was 1.36. The litter size of Patch-faced Maritza sheep breed in comparison with

other sheep breeds in the country is similar - Stancheva (2003) calculated 1.335 - 1.412, respectively, for first and second lactation (parity of lambing) for the Shumen region, and Dimov and Kuzmanova (2007) - 1.34 for the Plovdiv region. The average suckling period for Patch-faced Maritza breed was 62.50 days, which coincides with sheep of Bulgarian dairy synthetic population breeding under relatively similar conditions - 60 and 63.75 days (Ivanova, 2013; Zhelyazkova et al., 2014). Stancheva et al. (2018) established that for the suckling period of lambs from 61 to 70 days the average TDMY of Bulgarian dairy synthetic population was 0.773 L, which was a similar yield compared to the TDMY of the Patch-faced Maritza breed. This comparison discovered good potential for milk production of Patch-faced Maritza breed.

Table 1. Test day milk yield (TDMY), age at lambing, days in milk (DIM), suckling period and litter size (LS) of Patch-faced Maritza sheep breed.

Traits	n	\bar{x}	S.D.	CV, %	Min	Max
TDMY, mL	12 955	748.59	416.22	56	100	4000
Age at lambing, days	2881	1244.57	574.06	46	308	3627
Suckling period, days	2881	62.50	18.28	29	30	149
Litter size	2881	1.37	0.48	35	1	2>2

Note: \bar{x} - mean; S.D. - standard deviation; CV - coefficient of variation; Min - minimum value; Max - maximum value

The data in Table 2 reveal the age structure of the ewes in the flocks of Patch-faced Maritza sheep breed. The 10.83% of test day milk records belong to ewes that lambed as yearling ewes. The highest proportion of dairy records on the test day belongs to ewes that were 2- and 3-year-old (25.89% and 22.63%). A significant part in the age structure of the herds is represented by 4-, 5- and 6-year-old sheep, respectively - 17.46, 11.84 and 7.36 % or totally 36.66%, which forms a little more than one third of the population. A total of 3.99% of the dairy records in database belong to ewes that were 7 to 10 years old. This fact, which obviously is specific of the Patch-faced Maritza breed database, requires that age at lambing is taken into account when estimating the breeding values of ewes.

Table 2. Distribution of test day milk yield records in classes according to age of lambing (rounded to whole years) and relative share of age groups

Age at lambing years	Records n	Share of age groups %
1	312	10.83
2	746	25.89
3	652	22.63
4	503	17.46
5	341	11.84
6	212	7.36
7 - 10	115	3.99
Total	2881	100

The first three test day milk entries of ewes together represent 66.72% of the TDMY records for the entire database (Table 3). The decrease in the number of records after the third test day for ewes was due to the different durations of the milking period of different ewes in different flocks.

The differences in the length of the milking period in ewes were due to several reasons: the natural mating in the flocks and a long lambing campaign, individual ability of the ewes and the specific situations in each farm related to the sale of milk. In addition, in almost all breeds in Mediterranean areas, mature ewes lamb earlier than yearlings, so, for these classes milk yield differs not only in the age effect but also in a different milking length (Sanna et al., 2002). In accordance with our expectations, the highest milk yield was in the first test day of ewes (1015.80 mL). Gradually, milk yield decreased in the 7th test day (267.50 mL). The milk yield of the ewes was reduced by half compared to the fifth test day (505.68 mL). The share of test day records received from the 7th test day was non-significant (0.52%). The relatively high value of the standard deviation in the classes was an indication of a large variation in the test day milk records.

Table 3. Raw means and standard deviations of TDMYs, and DIMs depending on sequence of test days of Patch-faced Maritza sheep breed and relative share of the records in the test days

Sequence of test days	Records n	Relative share of records %	DIMs, days $\bar{x} \pm SD$	TDMYs, mL $\bar{x} \pm SD$
1	2881	22.24	76.48±19.18	1015.80±457.67
2	2881	22.24	107.19±19.49	865.39±395.67
3	2881	22.24	137.80±19.68	702.62±356.75
4	2190	16.90	167.97±19.24	577.49±305.53
5	1401	10.81	197.99±18.32	505.68±261.46
6	653	5.04	226.79±16.88	402.18±216.56
7 and more	68	0.52	261.06±13.88	267.50±120.05

Note: \bar{x} - mean; S.D. - standard deviation; % -relative share

To be included in the TDMs, environmental effects must have a significant effect at $p < 0.05$. All described environmental effects included in the analysis that may have influence on TDMY had significant effect ($p < 0.001$) (Table 4). A large part of the total phenotypic diversity was caused by factors such as animal (31.11%), age at test day (30.95%), DIM (27.85%), DIM3 (27.14%) and ewe

test day (21.92%). Among all the environmental effects with considerable influence, the largest proportion of the total phenotypic variation was explained by the factor flock-year-test day - 41.57%. The other effects, such as flock, year- season, parity, litter size and suckling period had a proportion of total variation lower than 10%, but their impact on milk yield in test day was significant ($p < 0.001$).

Table 4. Analysis of environment effects on test day milk yield of Patch-faced Maritza sheep breed and proportion of total variation (n=12955)

Environment effects	df	SS	F	P	%
Animal	1381	698204242.485	3.785	***	31.11
Flock	17	178994345.624	65.958	***	7.98
YS	63	148692386.158	14.519	***	6.63
Par	6	19408680.176	18.826	***	0.86
LS	1	6389709.256	36.986	***	0.28
AgeL	1036	365469048.201	2.238	***	16.29
AgeTD	1837	694679418.133	2.713	***	30.95
Suck	104	119322337.217	6.938	***	5.32
ETD	6	491961630.251	605.890	***	21.92
FTD	6	384043371.472	445.539	***	17.11
FYTD	516	932827376.925	17.147	***	41.57
DIM	255	624992235.777	19.222	***	27.85
DIM3	89	609179647.243	53.858	***	27.14
TOTAL	12954	2244182995.49			

Note: Animal - permanent effect of the animal; YS - year-season of lambing effect; Par - parity effect; LS - litter size; AgeL - age at lambing; AgeTD - age at test day; Suck - suckling period; ETD - ewe test day; FTD - flock test day; FYTD - flock-year-test day; DIM - effect of stage of lactation from day 30; DIM3 - effect of stage of lactation defined in three-day intervals starting from day 30; df - degree of freedom; SS - sum of squares; F - Fisher's criterion; P - degree of probability *** - $p < 0.001$; POV, % - Proportion of variation caused by environmental effects, %.

Conclusion

This study showed that the test day milk yield of Patch-faced Maritza sheep breed is significantly affected by many environmental effects. The production system, in which Patch-faced Maritza sheep were kept and the suckling period of 62 days limit the average test day milk yield to 748.59 mL, with a variation from 1015.80 mL from the first test day to 267.50 mL in the last test day.

Significant effects had animal, age at the test day, effect of stage of lactation, the sequence of test day for the ewes. The combination of effects flock-year-test day determines 41.57% of the phenotypic variation. The analysis of the environmental effects on test day milk yield of Patch-faced Maritza breed shows that the inclusion of the estimated environmental effects in test day models (TDMs) was important for the estimation of the genetic parameters and breeding values of the test day milk yield in sheep.

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