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LACTATION CURVE OF THE SHEEP FROM BULGARIAN DAIRY SYNTHETIC POPULATION

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ABSTRACT

The aim of the study was to analyze the lactation curve of ewes from Bulgarian Dairy Synthetic Population depending on test-day milk yield and parity. The analyzed data included 7,920 test – day records of 628 ewes from the herd of Agricultural Institute – Shumen, during the period 2009-2019. A mixed linear model was used and the analytical hypothesis included the factors: year and month of lactation, parity, type of lambing, test day (related to the lactation curve), suckling period, permanent effect of environmental changes, genetic value of the animal, random residual effects. The study established a typical, relatively flat lactation curve varying in depend and on test day and parity. Test-day milk yield is above or equal to the overall mean in the primiparous ewes, close or slightly lower at 2nd to 5th lactation and substantially lower from at 6th and 7th lactation.

Key words: sheep, Bulgarian Dairy Synthetic Population, milk productivity, lactation curve, Test-day model P.

Introduction

Dairy sheep constitute 75% of the sheep population in Bulgaria, most numerous being the representatives of the Bulgarian Dairy Synthetic Population (BDSP), registered in 2005. The methods of creation and formation of the new dairy population have been described by an array of authors (Hinkovski et al., 1984, 2008; Dimitrov, 1986; Vitkov, 1987; Tsvetanov, 1989; Dimov, 1995; Stancheva, 2003; Boykovski et al., 2005; Stancheva et al., 2014[a], 2016). On the basis of their good adaptive capacity, the BDSP sheep are spread across the country – mostly in developed farming plains and hilly areas. The prevailing production systems are low-budget, semi-intensive and extensive. This in itself means that achieving high milk productivity is difficult to attain. The available sources of information provide no official data on the level of productivity achieved in the private sector. Studies in the nucleus flocks of Agricultural Academy have shown that in recent years milk yield per standard 120-day milking period varies widely (76 – 133 l) and does not represent the genetic potential of the animals, in the range of 150 – 200 l (Raycheva and Ivanova, 2010, 2011[a,b]; Ivanova, 2013; Stancheva et al., 2014[a,b]; Slavova et al., 2015).

Milk production is to a large extent associated with the shape of lactation curve, the attained maximum daily milk yield during the lactation and its stability (gradual decrease after the peak) are key parameters (Pulina et al., 2007). Keskin (2006) and Koncagül et al. (2012) define lactation curve as a variability of milk yield over time, represented numerically on time basis or graphically in post-lambing diagrams. According Vázquez-Peláez et al., (2014), lactation curve is adequate defined as a useful tool in making management decisions and in developing strategies for genetic improvement of the evaluated group of animals. Lactation curve can be useful for biological and economic efficiency, selection, monitoring of animal health, rationing, animal care management, and feeding practices (Wood, 1967; Ruiz et al., 2000; Dağ et al., 2005; Koncagü l et al., 2012; Elvira et al., 2012;

Angeles-Hernandez et al., 2014). Like milk production, the nature and shape of lactation curve is influenced by breed, genotype, age, suckling period, lactation or milking period, changes in test-day milk yield, stage of lactation (test day, year and month of testing, day of lactation or milking period) and other environmental factors (Pollott and Gootwine, 2004; Oravcová et al., 2006, 2015; Tančin et al., 2011; Antonič et al., 2013; Pacinovski et al., 2014; Tekel et al., 2019; Robles Jimenez et al., 2020). Such studies are rarely conducted on national scale.

The aim of the study was to analyze the lactation curve in sheep from the Bulgarian Dairy Synthetic Population in dependence on test day and parity.

Materials and methods

Object of the study are ewes from the Bulgarian Dairy Synthetic Population, bred on the farm of the Agricultural Institute – Shumen. The flock is created by a specific modified breeding scheme, the genealogical structure having been developed in the early stages of crossing (Stancheva, 2003; Stancheva et al., 2016, 2017). For more than 30 years, "line breeding" with own-production rams has been carried out. The farming of the animals is free-stall with pasture as a semi-intensive production system. The used feeds are own production. Breeding is standard – once a year within the period June-July. The ewes are artificially inseminated under an individual breeding scheme at the age of 18 months, after the formation of the flocks. The lambing campaign is usually started in the second half of November and ended in mid-January. Machine milking is practiced twice daily, after weaning.

Milk productivity

The study assigned 7,920 milk yield records from the monthly test days (70 test days) of 628 ewes in the period 2009-2019. Milk yield data were obtained during the milking period by the AC method specified in the ICAR nomenclature, corresponding to 1,828 lactations for the entire productive life of the studied animals. The number of the established consecutive lactations was as follows: 1^{st} – 572; 2^{nd} – 463; 3^{rd} – 352; 4^{th} – 191; 5^{th} – 125; 6^{th} – 97; 7^{th} – 28. The first monthly test days were carried out in December – February (within 4 -15 days after starting the milking of the flock and within 52 days post weaning for each sheep), and the last test days – during May and June.

The pedigree matrix of the ewes includes a total of 903 individuals (pedigrees), 275 of them basic and 628 non-basic.

To analyze the factors affecting the studied trait – test-day milk yield – a mathematical model was developed on the basis of the following hypothesis:

milk yield per test day depends on the environmental conditions – year and month of lactation, parity, type of lambing (singles, twins…), test day order (related to lactation curve), suckling period, permanent effect of environmental changes, effect of the genetic value of the individual and random factors, not included and not explained in the model.

A test day model was used in which each test-day milk record was considered as a separate observation.

The following mixed linear model was used to achieve unbiased solutions:

$$Y_{ijklmnop} = YM_i + PAR_j + PK_k + SP_l + NL_m + p_n + A_o + e_{ijklmnop}$$

where:

Y^{-th} record of milk yield, in the **i**$^{-th}$ lactation month-year for the **j**$^{-th}$ lactation, at the **k**$^{-th}$ test day, **l**$^{-th}$ suckling period, for the **m**$^{-th}$ number of lambs borne at a lambing, which sets the beginning of the

controlled lactation, **n**$^{-th}$ effects caused by changes in the environment in the time of life of the lactating mother, **o**$^{-th}$ additive genetic effect of the controlled individual, **p**$^{-th}$ effect of uncontrollable factors.

- YM_{i-} i^{-th} fixed effect of year-lactation month;
- PAR_{j-} j^{-th} fixed effect of lactation (parity);
- PK_{k-} k^{-th} fixed effect of test day (sequence);
- SP_{l-} l^{-th} suckling period (covariable);
- NL_{m-} m^{-thi} fixed effect of number of lambs borne;
- P_{n-} n^{-the} random effect of the permanent environmental effect;
- A_{o-} o^{-the} random additive genetic effect of the individual;
- $e_{ijklmnop-}$ p^{-thi} random effect of uncontrollable factors.

When examining the lactation curve by lactation, the factor, effect of sequence on the control day, nesting, in the factor effect of successive lactation was interpreted.

The software products VCE by Kovac et al (2008), PEST by Groeneveld et al (2002) were used to achieve the above solutions.

Results and discussion

According to ICAR guidelines, milk productivity in most sheep breeds is calculated taking into account only milk yield during the milking period. In some systems of breeding (Israel, Germany), lambs are separated from their dams immediately after lambing, so the ewes are milked throughout lactation. For the ewes from the dairy breeds, the length of the milking period is an important system source for the changes in the environment and the variability of milk productivity (Carta et al., 2009). On the basis of these and other differences in managerial breeding systems, researchers have been exploring the possibility of using test-day milk yield to avoid the heterogeneity of data, associated with full lactation (Horstick, 2001; Serrano et al., 2001; Ligda et al., 2002; Othomane et al., 2002; Oravcová et al., 2005, 2006; Gutierrez et al., 2007; Bauer et al., 2012; Komprej et al., 2012).

The statistical parameters for some traits of the milk productivity of the ewes are shown in Table 1. Test-day milk yield (TDY) is 0,880 l ± 0,35 when the duration of the milking period is 139 days. This value is little lower than that established for sheep of the same group assessed for the period 2009-2014 – (TDY) 0,896 l ± 0,34 (Krastanov et al., 2018), which is somewhat logical and expected due to the increase in the values of the controlled trait associated with increasing parity of the ewes from 1th to 7th. Markedly higher is the daily milk yield of specialized dairy-purpose breeds East Friesian – 2,330 l (Hamann et al., 2004), Assaf – 1,930 l (Pollot and Gootwine, 2004), Lacaune – 1,640 l (Barillet et al., 2001), but it is necessary to account for the existing differences in the farming systems, the standard milking period (180 days for Assaf and 150 days for the East Friesian and Lacaune) and suckling period (zero for Assaf, 30 days for Lacaune and East Frisian). The established high variability of the studied traits and the substantial differences between the minimum and maximum values imply possibility of increasing the genetic potential of the animals not only via selection, but also through the optimization of the farming system.

Table 1: Statistical parameters for some traits of the milk productivity

Traits	n	Σ	SD	CV (%)	min	max
Test-day milk yield, TDY (l)	7920	0,880	0,35	40,0	0,200	3,142
Milk yield per milking period, TMM (l)	1828	119,868	37,56	31,0	36,000	297,000
Milk yield per standart 120^{-day} milking period, TMM^{120}(l)	1783	103,177	29,84	29,0	36,000	249,000
Milking period, (days)	1828	139	19,41	14,0	72	199
Suckling period, (days)	1828	48	13,21	27,0	19	97

The ideal lactation curve should have a relatively high peak and a flat trend after that, more stable lactations being associated with better animal health and reduced feeding costs (Pulina et al., 2007). On national scale, Dimov and Djorbineva (2007) established variation in the pattern of the lactation curves in ewes from the Stara Zagora breed, depending on the observed lactation month with peak TDY.

Figure 1 represents the overall lactation curve of the ewes represented as dynamics by test day. The observed curve has a specific shape corresponding to the natural course of lactation. Test-day milk yield is highest and over the overall mean on 1st and 2nd test day (0,906 and 0,886 l), negligibly lower on 3th test day (0,867 l) and gradually decreasing in the period of the next 3 test days. The results partly illustrate the relative persistency of lactation and are commensurate with those by other researchers showing higher values of milk yield in the first half of lactation in ewes (Horstick, 2001; Serrano et al., 2001; Ligda et al., 2002; Othomane et al., 2002; Pollott and Gootwine, 2004; Oravcová et al., 2005, 2006; 2015; Gutierrez et al., 2007; Bauer et al., 2012; Elvira et al., 2012; Komprej et al., 2012; Vázquez-Peláez et al., 2014; Pacinovski et al., 2014; Tekel et al., 2019; Robles Jimenez et al., 2020). These authors found that the type and shape of lactation curve is affected also by parity, daily milk yield being usually lowest during all stages of lactation after 1st lambing and increasing with the advance of parity.

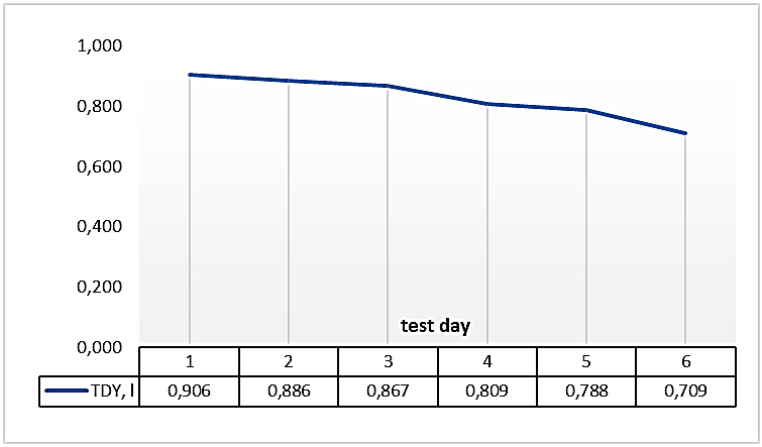
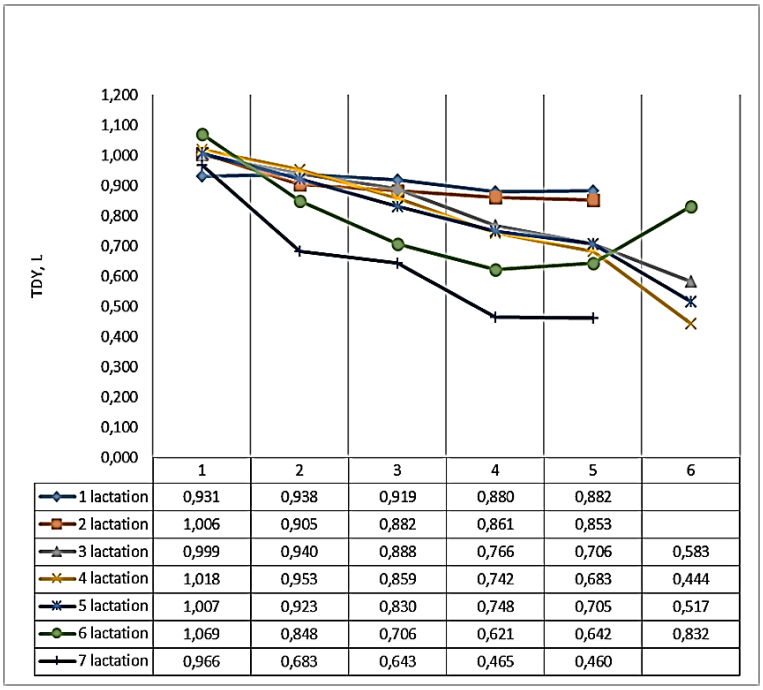


Figure 1: Overall lactation curve of the ewes expressed in test days

On Figure 2 are presented the overall lactation curves of the ewes, expressed as TDY dynamics by test day as dependant on parity. The observed lactation curves have specific (declining from the beginning to the end) shape with tendency for increase of milk production with the advance in age that is established to be contrary to the above cited reports. First-lactation ewes demonstrate the highest productivity. Test-day milk yield in them is above or equal to the overall mean for all consecutive test days, TDY on 2nd test day being slightly higher than that on the 1st test day (0,938 l and

0,931 l). The ewes retain their high milk yield on the next, second lactation**.** At this lactation, test-day milk yield values for 1st to 3rd test day are above the overall mean values for these test days (1,006; 0,905 and 0,882 l), and after that the productivity gradually decreases during the lactation. Ivanova and Raicheva (2008), Raicheva and Ivanova (2011[b]) and Ivanova (2013) have also established specific shape of the lactation curve for 1st and 2nd lactation with minor differences in milk yield from 1st to 3rd test day in BDSP ewes from the flock of the Animal Institute – Kostinbrod. In the ewes at 3rd, 4th and 5th lactation, test-day milk yield remains above or slightly lower on 1st to 3rd test day as compared to the overall mean values on these test days, but on the further test days it is considerably lower than at 1st and 2nd lactation. The lower productivity belongs to the ewes on 6th and 7th lactation. The test-day yield is above the overall mean only on 1st test day and substantially lower for all subsequent test days, as compared to the milk yield of the ewes from 1st to 5th lactation.



	1	2	3	4	5	6
1 lactation	0,931	0,938	0,919	0,880	0,882	
2 lactation	1,006	0,905	0,882	0,861	0,853	
3 lactation	0,999	0,940	0,888	0,766	0,706	0,583
4 lactation	1,018	0,953	0,859	0,742	0,683	0,444
5 lactation	1,007	0,923	0,830	0,748	0,705	0,517
6 lactation	1,069	0,848	0,706	0,621	0,642	0,832
7 lactation	0,966	0,683	0,643	0,465	0,460	

Figure 2: Lactation curves of the ewes expressed in test days as dependant on parity

The results are indicative that the whole selection policy, the breeding schemes and strategies in the sheep have been conducted adequately for the progress of the flock, so the animals express their genetic potential as early as at first lactation. The negligible differences in milk yield in the ewes between first and second lactation presumably implies that at first lambing the ewes were well developed bodily**.** Similar are the results of Pollott and Gootwine, (2004) in Assaf ewes and Elvira et al., (2012) in Lacaune. The observed lower milk production at the subsequent lactations suggests that changes have occurred in the technological factors, and that there have been untimely culling of the animals with lower milk yield after first to third lactation. In view of the fact that in sheep breeding the purpose is to obtain larger number of lambs, these decisions are based on their higher prolificacy. It is quite obvious, however, that keeping ewes for more than five lactations has the sooner a negative effect on the milk productivity of the flock.

Conclusion

The study established a typical, relatively flat lactation curve in the ewes from the Bulgarian Dairy Synthetic Population, varying in dependence on test day and parity.

As parity increases, milk productivity decreases.

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