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INFLUENCE OF PRODUCTION YEAR ON THE MILK PRODUCTIVITY IN EWES FROM THE BULGARIAN DAIRY SYNTHETIC POPULATION

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Abstract

The purpose of the study was to investigate the influence of production year on the milk yield per standard 120-day milking period of sheep from the Bulgarian Dairy Synthetic population in the flock of Agricultural Institute-Shumen. Milk productivity data of 2193 sheep of different ages for six production years, were analysed. For the individual years, the following were determined: duration of lactation and milking period, milk yield per milking period (TMM), average daily milk yield per milking period ($ADMY^{milking\ period}$) and milk yield per 120-day standard milking period (TMM120). The influence of the production year on milk yield per standard 120-day milking period was determined by the ANOVA model for one-way analysis of variance. The total milk productivity for the standard 120-day milking period of sheep in the individual production years was within 94.798-115.541 l, with the determined differences having a high degree of significance (P≤0.001). A highly significant effect of the production year factor on the milk yield per standard 120-day milking period per consecutive lactation was established.

Key words*: Bulgarian Dairy Synthetic Population, milk productivity, production year, sheep.*

INTRODUCTION

Sheep, milk productivity is significantly affected by various genetic (intrinsic) and non-genetic (extrinsic) factors. Their impact is usually simultaneous, and it is difficult to determine the extent of their separate influence (Adamu, 2021; Ali et al., 2020; Alkass & Akreyi, 2016; Al-Najjar et al., 2022; Assan, 2020; Carta et al., 2009; Gonzalez-Ronquillo et al., 2021; Jawasreh & Khasawneh, 2007; Libis-Márta, et al., 2021; Oravcova et al., 2006, 2007; Pacinovski et al., 2012, 2016; Pulina et al., 2007; Robles Jimenez et al., 2020; Selvaggi et al., 2017). Dairy sheep breeding in Bulgaria has deep traditions and nowadays, dairy sheep make up about 75% of the total population and give the largest share of sheep breeding production. Commercial breeds for milk are represented, to the highest degree, by sheep from the Bulgarian Dairy Synthetic Population (BDSP), the Lacaune, Assaf and Avasi breeds. According to the data of the Executive Agency for Selection and Reproduction in Livestock Breeding, in 2023 the following are covered under selection control: 172861 sheep from BDSP; 17130 sheep of the Lacaune breed; 16652 sheep of the Assaf breed and 2592 sheep of the Awassi breed. The number of sheep from other local and imported dairy breeds is significantly lower. It is quite obvious that sheep from BDSP have a leading role in the production of milk, meat and derived products for feeding the population. The main goal of the selection is to increase milk productivity combined with good fertility. Although the animals have the potential for high milk yield (150-200l per milking period), the achieved results are unsatisfactory (Iliev et al., 2022; Ivanova, 2013; Slavova et al., 2015; Slavova & Stancheva 2023; Stancheva et al., 2014; 2018; 2021; 2022; Zhelyazkova et al., 2014). In all studies, the authors conclude that the realization of the genetic potential of BDSP sheep depends mostly on the provided conditions of nutrition, breeding, management of the production system. The production year, which largely takes into account the influence of so-called external factors (production system, rearing conditions, health status, nutrition, physiological condition of the animals, management and marketing strategy on the farm, specific daily animal care, etc.) probably has a significant effect on the dynamics of milk productivity and the realization of the genetic

potential of sheep. This also motivates our present study.

The purpose of the study was to determine the influence of the production year on the milk yield for a 120-day standard milking period of the ewes from the Bulgarian Dairy Synthetic population in the flock of the Agricultural Institute - Shumen.

MATERIALS AND METHODS

The study covered 2193 ewes from the Bulgarian Dairy Synthetic Population, bred at the Agricultural Institute - Shumen. The sheep were of different ages (from the 1st to the 7th lactation) and produced in the period 2015-2020. They are divided into 3 flocks and were raised on barn and pasture under a semi-intensive system. Animals designated for breeding are kept separately until they enter the main herd, at the age of 18 months. The animals were fed with their own feed. The lambing season usually takes place from the second half of November and ends by the middle of January. Milking is by machine in a milking parlor and twice a day after the lambs are weaned.

Figure 1. Monthly milk control in the flock of the Agricultural Institute - Shumen (own source)

Milk productivity

A total of 2193 milk yield records per milking period, average daily milk yield per milking period, length of lactation and milking period and 2010 milk yield records for 120-day standard milking period of ewes during the production years studied were analyzed. Milk yield data were obtained by measuring the amount of milk in liters milked during the milking period of the animals according to the AC method specified in the nomenclature of the International Animal Control Committee (ICAR). The first monthly controls were carried out in the months of December - February, and the last - in May and June. The milk yield of each sheep for the control day is the amount of milk in the morning individual control multiplied by the coefficient of the flock (K = morning + evening milk/morning milk). Milk yield per milking period (TMM) is the sum of the milk yield from the individual control periods of each ewe. The average daily milk yield for a milking period ($ADMY^{milking\ period}$) is the amount of milk received per milking period divided by the duration of the milking period in days. Milk yield for a standard 120 day milking period (TMM120) is the average daily milk yield for a milking period multiplied by 120 days ($TMM120 = ADMY^{milking\ period} * 120$). For the individual production years, the average statistical parameters were established for: duration of lactation and milking period, milk yield per milking period (TMM), average daily milk yield per milking period ($ADMY^{milking\ period}$) and milk yield per standard 120-day milking period (TMM120) (total and after another lactation). Due to the relatively small number of ewes in the 6th and 7th lactation, their milk yield data for a standard 120-day milking period were grouped into one category 5+, so that 5 levels were obtained for TMM120 per consecutive lactation. The obtained results were processed using the software Statistica. The influence of the production year on the milk yield for a 120-day standard milking period (total and consecutive lactation) was determined by the one-way analysis of variance ANOVA model.

RESULTS AND DISCUSSIONS

The statistical parameters for the investigated signs of the total milk productivity of sheep for the production years 2015-2020 are shown in Table 1. The duration of the lactation and milking period is an important systemic source for environmental changes and variability of milk productivity. The average duration of the mammary and milking period in the studied years varies from 52 to 59 days for the former, and is within 131-162 days for the latter. The

significant differences between the established minimum and maximum values are indicative of the need for changes in the management of the production system on the farm. In this direction, the reduction of the lactation period is a significant reserve for extending the milking period and increasing the amount of milk obtained for sale (Simeonov et al., 2012; Ivanova et al., 2015; Mavrovska, 2015; Stancheva et al., 2018; Miteva, 2022). Milk yield per milking period increased to 139.681 l in 2019 and decreased to 120.559 l in the following year, 2020. The values of the average daily milk yield for the milking period gradually increased until the year 2017 ($ADMY^{milking}$ period 0.935 l), after which they significantly decreased. As unfavorable, we can point out the production years 2015, 2016 and 2020, where the values for milk yield per milking period (103.625 l, 119.657 l and 120.559 l) and average daily milk yield per milking period (0.791 l, 0.838 l and 0.824 l) are the lowest.

Table 2 shows the total average values of milk yield for a 120-day standard milking period (TMM120) for the period 2015-2020, depending on the production year and the sequence of lactations. For the study period, the average value of milk yield per 120-day standard milking period (TMM120) was 103.379 l. The level achieved is well below the set breeding target of 150 l and below, the minimum selection limit for the Elite class of the population (105 l). The high variability of the trait is illustrated by the standard deviation values (SD 30.34).

Depending on the production year, the milk yield for a 120-day standard milking period increased to 115.541 l in 2017, after which it significantly decreased. The lowest, and with values below the general average, is the milk yield of the sheep produced in 2015, 2016 and 2020 (94.798 l, 99.624 l and 98.641 l). In our opinion, these results do not reflect the genetic endowments of the animals, but rather are due to various, non-biological factors such as rearing conditions, unbalanced nutrition in relation to the physiological state of the animals, daily care and health status of the animals, gaps in husbandry technology and non-genetic interactions. Analysis of variance reported a highly reliable effect of year of production on total milk yield of ewes over a 120-day standard milking period. A reliable effect of the year of production was found by Zhelyazkova et al. (2014) in SPBM sheep bred in two private flocks, Al-Najjar et al. (2021), Jawasreh and Khasawneh (2007), Pacinovski et al. (2016), Üstüner and Mustafa (2013) on Awassi sheep bred in Jordan, Turkey and its crosses in Macedonia, Selvaggi et al. (2017) on three Italian sheep breeds. It is known that the milk productivity of ewes increases with the succession of lactations (Hinkovski et al., 2008; Ivanova, 2013; Iliev et al., 2021; Kasap et al., 2019; Miteva, 2022; Slavova et al., 2015; Robles Jimenez et al., 2020; Selvaggi et al., 2017; Sezenler et al. 2016). Our obtained results are not exactly like that (Table 2). The average milk yield values for a 120-day standard milking period are higher than or close to the total flock average by the 4th lactation as for ewes at 1st lactation are the highest (107.747 l). It can be seen that the animals show their genetic potential for high milk yield already in their 1st lactation. Similar results were obtained by Pollott and Gootwine (2004) in sheep of the Assaf breed and Elvira et al., (2012) in the Lacaune breed. In the next two lactations, the mean values of the trait decrease, but the milk yield achieved for a 120-day standard milking period still approaches the population Elite class limit (105 l) in ewes of the 4th lactation (103.129 l). We found significantly lower milk productivity in the animals of the 5th and more lactations, as the milk yield for a 120-day standard milking period (90.176 l) does not cover the selection limits for the 1st class of the population (95 l). The analysis of variance here also reports a highly reliable effect of the production year on the milk productivity of the sheep for a 120-day standard milking period per consecutive lactation.

Table 3 shows the total average values of milk yield for a 120-day standard milking period (TMM120) by consecutive lactation, during individual production years. The results show that in the 1st lactation, the milk yield for a 120-day standard milking period increases until 2018-2019 years, after which it significantly decreases. The highest, and with values exceeding the selection limits for the Elite class, is the milk yield of sheep in the years 2018, 2017, 2019 and 2020 (115.413 liters, 114.851 liters, 114.152 liters and 107.427 liters). The milk yield of 2nd lactation ewes does not

increase significantly compared to the milk productivity of 1st lactation ewes. The highest, and with values exceeding the selection limits for the Elite class, is the milk yield for a 120-day standard milking period in the years 2017, 2018 and 2019 (118.545 l, 115.306 l and 107.511 l). Although the milk yield of the sheep in 2015, 2016 and 2020 was lower, it still approached the Elite class limit of the population in 2020 (103.408 l) and exceeded the requirements for I class in the animals produced in 2015 and 2016 (98.501 l and 100.319 l).

Table 1. Statistical parameters for some traits of the milk productivity by production year

Traits / Year	n	*x*	SD	Min.	Max.
year 2015					
Suckling period (days)	365	53	8.01	26	77
Milking period (days)	365	131	12.20	67	141
TMM (l)	365	103.63	31.27	25.625	219.921
ADMY milking period (l)	365	0.791	0.22	0.279	1.560
year 2016					
Suckling period (days)	373	54	13.50	7	114
Milking period (days)	373	143	24.00	42	170
TMM (l)	373	119.657	41.17	10.385	266.896
ADMY milking period (l)	373	0.838	0.27	0.247	1.822
year 2017					
Suckling period (days)	370	58	9.71	24	94
Milking period (days)	370	134	20.97	42	192
TMM (l)	370	127.36	44.54	20.536	269.171
ADMY milking period (l)	370	0.935	0.27	0.298	1.831
year 2018					
Suckling period (days)	353	52	12.32	18	97
Milking period (days)	353	148	19.76	58	182
TMM (l)	353	134.86	48.61	25.748	308.611
ADMY milking period (l)	353	0.907	0.29	0.303	1.868
year 2019					
Suckling period (days)	384	52	54.00	5	80
Milking period (days)	384	162	17.25	58	213
TMM (l)	384	139.68	46.11	31.238	258.863
ADMY milking period (l)	384	0.854	0.25	0.336	1.523
year 2020					
Suckling period (days)	348	59	12.61	7	85
Milking period (days)	348	146	17.39	57	193
TMM (l)	348	120.56	38.06	21.684	261.041
ADMY milking period (l)	348	0.824	0.24	0.380	1.729

On the next 3rd lactation, a drop in milk productivity was observed, except for the milk yield of the ewes lactating in 2018 (132.263 liters), which significantly exceeded the general average for the flock and the selection limits for the Elite class of the population. For the animals that produced in the remaining production years, the milk yield for a 120-day standard milking period is within the limits of 90.188 liters in 2015 to 108.254 liters in 2019. The decrease in milk productivity continues in the next 2 lactations. In the ewes of the 4th lactation, the highest, and with values exceeding or equal to the selection limits for the Elite class, is the milk yield for a 120-day standard milking period in the years 2018 and 2017 (122.330 liters and 105.905 liters). During the rest of the production years, the milk productivity of the animals meets the requirements for the 1st class of the population. We found significantly lower milk productivity in the animals of the 5th and more lactations, as the milk yield of the sheep for a 120-day standard milking period exceeded the selection limits for the 1st class of the population, only in 2016 and 2017 (99.572 liters and 103.431 liters). The established differences in the milk productivity of sheep during individual production years have a high degree of reliability for all lactations ($P \leq 0.001$).

Table 2. Overall mean and analysis of variance for a milk yield per standard 120-day milking period, (l) (period 2015-2020 years)

Variable	Milk yield per standart 120-day milking period (TMM^{120}), (l)			*P*-value
	n	*x*	*SD*	
TMM^{120}, total	2010	103.379	30.34	
TMM^{120} by production year				
year 2015	347	94.798	25.64	**0.000000**
year 2016	334	99.624	28.97	
year 2017	324	115.541	30.51	
year 2018	320	109.107	34.12	
year 2019	370	103.327	29.39	
year 2020	315	98.641	28.63	
TMM^{120} by parity				
1st lactation	520	107.747	30.59	**0.00000**
2nd lactation	475	106.615	28.02	
3rd lactation	388	105.017	31.69	
4th lactation	296	103.129	28.67	
5th+ lactation	331	90.176	29.47	

**P≤0.001

The results thus obtained confirm the thesis expressed by us and other authors that the phenotypic variations of milk productivity and the manifestation of the genetic potential of sheep are directly related to the year of production, which largely takes into account the influence of so-called external (non-genetic) factors. Most of them (production system, rearing conditions, health status, complete nutrition according to the physiological condition of the animals, availability of pastures and nutritional composition, management and marketing strategy in the farm, the specific daily care of the animals, etc.) can be controlled and systematically improved.

Table 3. Overall mean and analysis of variance for a milk yield per standard 120-day milking period (consecutive lactation) by production year (l)

Variable	n	*x*	SD	P-value
1st lactation				
year 2015	117	97.887	26.19	**0.000022**
year 2016	84	101.530	30.32	
year 2017	64	114.851	28.81	
year 2018	84	115.413	34.56	
year 2019	94	114.152	28.90	
year 2020	77	107.427	31.19	
2nd lactation				
year 2015	92	98.501	21.69	**0.000003**
year 2016	83	100.319	27.418	
year 2017	79	118.545	29.53	
year 2018	57	115.306	30.03	
year 2019	87	107.511	28.65	
year 2020	77	103.408	26.34	
3rd lactation				
year 2015	77	90.188	28.07	**0.000000**
year 2016	75	99.111	26.89	
year 2017	64	132.263	30.71	
year 2018	59	107.459	36.63	
year 2019	51	108.254	24.02	
year 2020	62	97.469	24.86	
4th lactation				
year 2015	35	94.052	23.11	**0.000001**
year 2016	55	96.398	31.09	
year 2017	62	105.905	24.63	
year 2018	54	122.330	25.70	
year 2019	52	98.507	28.01	
year 2020	38	95.744	20.05	
5th+ lactation				
year 2015	26	81.301	25.28	**0.000544**
year 2016	37	99.572	31.09	
year 2017	55	103.431	30.87	
year 2018	66	86.384	30.29	
year 2019	86	87.253	27.55	
year 2020	61	84.532	26.33	

*P≤0.001

CONCLUSIONS

The total milk yield of the sheep for a 120-day standard milking period (103.379 l ±30.34) is close to the minimum threshold limit for the Elite class of the population. The same, it is

within 94.798- 115.541 l, during the individual production years and is the highest in the sheep of the 1st lactation (107.747 l).

A significant effect of the production year factor on the total milk productivity for a 120-day standard milking period and the milk yield of ewes per consecutive lactation were established.

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