Research on Some Factors Influencing the Milk Production Indices in Romanian Black and White Cows

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Abstract

Researches were carried out in 60 dairy farms rearing 658 Romanian Black and White (RBW) cows. Dairy cows were enrolled in the official performance control, performed by a local association. Farms were categorized by size (number of dairy cows) as small (≤10), medium (11-25) and large (>25), according to the specific conditions in Hunedoara County. Besides the farm size, the influence of calving season and parity was assessed on the milk production indices: milk yield, fat percentage and yield, and protein percentage and yield. Maturity equivalent (ME) milk, fat and protein yields were 50% ($p<0.01$) higher in large farms (7549± 87.44 kg milk, 309.6± 4.05 kg fat, and 252.9± 2.90 kg protein) than in medium and small farms. Fat and protein percentages in milk increased as cows grew older (by 3-5%, $p<0.001$). Calving season had a significant influence on ME milk production indices, as well ($p<0.01$). Thus, milk yield, fat yield, fat percentage and protein yield were higher in winter calvings (7175.9 kg vs. 7060.8 kg, 292.1 kg vs. 286.1 kg, 4.1% vs. 4.0% and 247.9 kg vs. 237.6 kg, respectively), while milk protein percentage was higher in summer calvings (4.3% vs. 3.6%).

Keywords: cows, farm size, milk production, Romanian Black and White, season.

1. Introduction

Milk production is influenced by a variety of factors with direct or indirect action on the animal body. In general, these factors act concurrently, but with a different intensity, on both quantitative milk production and the chemical composition of milk. In principle, the lactation order correlates with the age of the cows, the quantitative production of milk varying during the lifetime of the animals from one lactation to another. [1] The main factors of milk production variation from one lactation to another are the following: the intensity of metabolic processes, the histological structure and the capacity (volume) of the udder, as well as the capacity of the digestive tract. In this sense, at the beginning of productive life, when the general metabolism is in excess (anabolic processes are predominant), milk production increases from one lactation to another and reaches the maximum level at adult age when general metabolism is balanced [2].

Knowing how milk production varies according to the age of the animals (lactation order) is of particular practical and economic importance. Thus, economically and practically, and from the point of view of the genetic improvement process, those cows who achieve the highest productive level at a younger age, maintain this productive level for as long as possible and at first lactation achieve a milk production closest to the maximum lactation yield are to be selected [3].

The calving season influences individual milk production, both through diet structure and the feeding level, as well as a result of the influence of specific climatic factors of each calendar season.

The main cause that results in lower milk yields on lactation in dairy cows during spring and

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summer calving compared to autumn-winter calving cows is the temperature [4].
The high ambient temperature has a negative influence on the appetite of the animals, which leads to a reduction in the voluntary consumption of feed, even during the period when the cows are in the ascending or plateau phases of the lactation curve, during which the nutrient requirements for supporting lactation are very high [5].
In the case of autumn-winter calvings, the rational feeding of dairy cows in the ascending and plateau phases of the lactation curve (when, physiologically, the intensity of milk synthesis is high), coupled with stimulation of milk synthesis through green fodder in the spring (when milk production is in the descendant phase of the lactation curve), results in a higher milk production on the current lactation [6].
The objective of the study was to assess the effects that farm size, calving season and lactation order has on the milk production indices during lactation.

2. Materials and methods

Researches were carried out on cows from 60 dairy farms, enrolled in the official performance control in a breeding association in Hunedoara County. The total number of animals was 658 Romanian Black and White cows. The farms were divided into three categories according to their size, as follows: small (n≤10 cows), medium (n=11-25 cows) and large (n>25 cows).
The following factors of influence were studied: farm size, calving season and lactation order on milk production per real lactation, farm size and calving season on milk production indices per normal lactation (305 days) and mature equivalent (ME) lactation. The milk production indices were: milk yield, fat percentage, fat yield, protein percentage and protein yield.
Database was analysed using STATISTICA software, and the model used was the Main effect ANOVA, using the following equations:

$$y_{ijklm} = SIZE_j + SEASON_k + PARITY_l + e_{ijklm}$$

for real lactation, and

$$y_{ijkl} = SIZE_j + SEASON_k + e_{ijkl}$$

for normal and ME lactations.
where: SIZE was the effect of the farm size with 3 levels: small, medium and large, SEASON was the effect of calving season with two levels: summer and winter, and PARITY was the effect of lactation order with 3 levels: first, second and third plus over lactation.

3. Results and discussion

Averages, dispersion indices and statistical significance for real milk production according to the farm size are presented in Table 1. One can observe that there were very close values for all milk production indices between small and medium farm size, differences being non-significant statistically (p>0.05). Exception is the milk fat percentage that was higher in medium sized farms compared to small sized farms (4.1± 0.75 vs. 3.98± 0.09, p< 0.01).

Table 1. Averages, dispersion indices and statistical significance for **real milk production** according to the **farm size**

Milk production indices	Statistics	Farm size			Significance		
		Small (n=47)	Medium (n=65)	Large (n=546)	Small vs. Medium	Small vs. Large	Medium vs. Large
Total days in milk	Average ± SEM	320.9±16.98	310.3± 11.26	359.5± 5.10	ns	**	**
	SD	116.42	90.79	119.20			
Milk yield (kg)	Average ± SEM	4847.1±237.3	4929.8± 223.6	8171.1± 144.2	ns	***	***
	SD	1627.14	1802.38	3369.46			
Fat yield (kg)	Average ± SEM	194.9± 11.86	199.6± 8.96	347.3± 6.50	ns	***	***
	SD	81.35	72.25	151.90			
Fat percentage (%)	Average ± SEM	3.98± 0.09	4.1± 0.75	4.2± 0.02	**	***	**
	SD	0.67	0.61	0.53			
Protein Yield (kg)	Average ± SEM	165.6± 8.72	165.1± 7.29	281.1± 4.99	ns	***	***
	SD	59.82	52.82	116.71			
Protein percentage (%)	Average ± SEM	3.4± 0.03	3.4± 0.02	3.4± 0.01	ns	ns	ns
	SD	0.26	0.19	0.22			

ns = p>0.05, p<0.05*, p<0.01**, p<0.001***

Except protein percentage, the highest milk production, for all indices, was obtained in large farms: 8171.1± 144.2kg milk, with 4.2± 0.02% fat, 347.3± 6.50 kg fat and 281.1± 4.99 kg protein, obtained in 359.5± 5.10 days of lactation. This production was significantly higher ($p<0.001$; $p<0.01$) than that obtained from small as well as medium farms.

The season of calving also influences the chemical composition of milk, especially its fat content [7]. Thus, the highest fat percentage per lactation is recorded in cows that are calving in the winter; the milk fat percentage starts to decrease in cows calving during May to achieve the lowest value in cows calving in July and August, after which the fat percentage starts to increase again [8]. Differences in the average milk fat percentage according to the calving season were between 0.2% and 0.4%. Seasonal variations in the chemical composition of milk are determined by the combined action of a complex of factors of influence, including: diet structure and feeding level, microclimate factor dynamics (temperature, relative air humidity, airflow velocity), as well as and the exploitation system [9].

Table 2 presents the averages, dispersion indices and statistical significance for real milk production according the calving season.

Table 2. Averages, dispersion indices and statistical significance for **real milk production** according to the **calving season**

Milk production indices	Statistics	Calving season		Significance
		Winter (n=365)	Summer (n=293)	
Total days in milk	Average ± SEM	357.1± 6.01	345.4± 7.07	ns
	SD	114.70	120.96	
Milk yield (kg)	Average ± SEM	7725.6± 171.67	7473.7± 204.81	*
	SD	3279.72	3505.91	
Fat yield (kg)	Average ± SEM	324.6± 7.69	318.3± 9.32	*
	SD	146.92	159.53	
Fat percentage (%)	Average ± SEM	4.2± 0.02	4.2± 0.03	ns
	SD	0.55	0.51	
Protein yield (kg)	Average ± SEM	263.4± 5.88	258.8± 7.21	ns
	SD	112.40	123.48	
Protein percentage (%)	Average ± SEM	3.4± 0.01	3.5±0.01	**
	SD	0.20	0.24	

ns = $p>0.05$, $p<0.05$*, $p<0.01$**, $p<0.001$***

Milk and fat yields were significantly ($p<0.05$) higher in winter than in summer (7725.6± 171.67kg vs. 7473.7± 204.81kg and 324.6± 7.69kg vs. 318.3± 9.32kg, respectively). A significant difference was observed for protein percentage ($p<0.01$). In this case, cows calving during the summer time had, on average, higher milk protein percentage per real lactation than cows calving during winter (3.5%±0.01 vs. 3.4%±0.01).

Analysing the results for real milk production according to the parity (Table 3), one can observe that the highest milk production was obtained in the second lactation and after that the milk production indices decreased as cows grew older. Exception to this trend was the total DIM which was the highest in first lactation, decreased to the second lactation and was the lowest in the third and over third lactations (367.6 ±7.61 days, 349.8 ±9.24 days and 342.7 ±7.12 days, respectively).

Comparing the first and second lactations, the milk production indices were higher in the second lactation than in the first lactation, but the increase was statistically assured only for fat yield, fat percentage and protein percentage. Compared to the third lactation and over, milk yield and protein percentage in the first lactation were similar ($p>0.05$), except for milk fat yield and percentage and protein yield that were significantly higher in the first lactation (305.3 ±9.42 kg vs 325.6 ±9.10 kg., 4.1±0.01% vs.4.2±0.02% and 248.3 ±7.23 kg vs.266.2 ±6.99 kg, respectively).

Real milk production in the second lactation was significantly higher ($p<0.001$) for all indices than in the third and over third lactation.

The way in which the farm size influences the normal milk production (305 days) is shown in Table 4.

Milk production per normal lactation was similar ($p>0.05$) between small and medium size farms,

except for the fat percentage that was significantly lower in small than in medium farms (3.9 ± 0.03% vs. de 4.0± 0.02%, p<0.001).

Table 3. Averages, dispersion indices and statistical significance for **real milk production** according to the **parity**

Milk production indices	Statistics	Lactation			Significance		
		L1 (n=197)	L2 (n=157)	L3 and over (n=304)	L1 vs L2	L1 vs L3	L2 vs L3
Total days in milk	Average ± SEM	367.6±7.61	349.8±9.24	342.7±7.12	ns	*	ns
	SD	106.85	115.87	124.22			
Milk yield (kg)	Average ± SEM	7704.1±200.8	8077.6±271.22	7314.9±210.8	ns	ns	**
	SD	2818.41	3398.45	3675.64			
Fat yield (kg)	Average ± SEM	325.6±9.10	349.1±12.31	305.3±9.42	*	*	**
	SD	127.73	154.27	164.33			
Fat percentage (%)	Average ± SEM	4.2±0.02	4.3±0.02	4.1±0.01	*	*	**
	SD	0.51	0.57	0.56			
Protein Yield (kg)	Average ± SEM	266.2±6.99	280.7±9.54	248.3±7.23	ns	*	**
	SD	98.11	119.58	126.14			
Protein percentage (%)	Average ± SEM	3.4±0.01	3.5±0.02	3.4±0.01	**	ns	**
	SD	0.20	0.24	0.22			

ns = p>0.05, p<0.05*, p<0.01**, p<0.001***

The highest values for milk production per normal lactation were obtained in the large farms. Compared to small farms, differences were significantly higher (p<0.001) for all the milk indices in large farms. Compared to medium farms, the trend was the same, meaning that production per normal lactation was significantly higher in large farms (p<0.001).

Table 4. Averages, dispersion indices and statistical significance for **normal milk production** according to the **farm size**

Milk production indices	Statistics	Farm size			Significance		
		Small (n=47)	Medium (n=65)	Large (n=546)	Small vs. Medium	Small vs. Large	Medium vs. Large
Milk yield (kg)	Average ± SEM	4527.5± 165.5	4558.6± 188.50	7003.6± 94.84	ns	***	***
	SD	1135.29	1519.76	2216.14			
Fat yield (kg)	Average ± SEM	178.3± 8.68	180.70± 7.37	290.1± 4.20	ns	***	***
	SD	59.55	56.83	97.85			
Fat percentage (%)	Average ± SEM	3.9± 0.03	4.0± 0.01	4.1± 0.01	***	***	***
	SD	0.66	0.63	0.49			
Protein Yield (kg)	Average ± SEM	152.4± 5.70	151.6± 4.56	237.7± 3.80	ns	***	***
	SD	39.08	42.35	74.48			
Protein percentage (%)	Average ± SEM	3.3± 0.01	3.3± 0.01	3.4± 0.01	ns	***	***
	SD	0.22	0.23	0.21			

ns = p>0.05, p<0.05*, p<0.01**, p<0.001***

Cows calving during the winter season (Table 5) produced more milk yield, fat yield and protein yield per normal lactation compared to cows calving during the summer season (6676.85±114.18kg vs. 6471.1±141.21kg milk, 274.1±5.15kg vs. 267.6±4.34kg fat and 224.8±3.85kg vs. 221.1±4.8 kg protein. Fat and protein percentages were significantly higher in cows calving during summer compared to cows calving during winter season.

Averages, dispersion indices and statistical significance for ME corrected milk production according to the farm size are presented in Table 6. Comparing small and medium farms it was observed only a significant difference for fat percentage, which was higher in medium farms than in small farms (4.0± 0.02% vs. 3.8± 0.03 %, p<0.001).

All the EM corrected ilk indices were significantly higher (p<0.001) in large farms than in small

farms. Except for the fat percentage, which was similar (p>0.05), the EM milk production indices were significantly higher (p<0.001) in large than in medium farms.

ME corrected milk yield, fat yield and protein yield were significantly higher in the winter season calving cows (Table 7) compared to summer calving cows (p<0.001). The production was 7175.9± 109.05kg ME milk, 292.1± 5.16kg ME fat and 247.9± 1.63kg ME protein in winter compared to 7060.8± 129.32kg EM milk, 286.06± 5.72ME fat and 237.6±1.78kg ME protein fat in summer. ME fat and protein percentages were significantly higher in summer than in winter calving cows (p<0.001).

Table 5. Averages, dispersion indices and statistical significance for **normal milk production** according to the **calving season**

Milk production indices	Statistics	Calving season		Significance
		Winter (n=365)	Summer (n=293)	
Milk yield (kg)	Average ± SEM	6676.85±114.18	6471.1±141.21	***
	SD	2181.52	2417.19	
Fat yield (kg)	Average ± SEM	274.1±5.15	267.6±4.34	**
	SD	98.54	87.34	
Fat percentage (%)	Average ± SEM	4.1±0.01	4.2±0.02	**
	SD	0.58	0.55	
Protein Yield (kg)	Average ± SEM	224.8±3.85	221.1±4.8	*
	SD	73.67	78.43	
Protein percentage (%)	Average ± SEM	3.3±0.01	3.4±0.01	**
	SD	0.22	0.23	

ns = p>0.05, p<0.05*, p<0.01**, p<0.001***

Table 6. Averages, dispersion indices and statistical significance for **maturity equivalent (ME) milk production** according to the **farm size**

Milk production indices	Statistics	Farm size			Significance		
		Small (n=47)	Medium (n=65)	Large (n=546)	Small vs. Medium	Small vs. Large	Medium vs. Large
Milk yield (kg)	Average ± SEM	5072.5± 164.5	5042.4± 155.63	7549.2± 87.44	ns	***	***
	SD	1128.31	1254.73	2043.37			
Fat yield (kg)	Average ± SEM	196.3± 8.51	200.4± 6.31	309.6±4.05	ns	***	***
	SD	58.35	50.87	94.67			
Fat percentage (%)	Average ± SEM	3.8± 0.03	4.0± 0.02	4.0± 0.01	***	***	ns
	SD	0.68	0.62	0.49			
Protein Yield (kg)	Average ± SEM	165.4± 5.08	163.53± 5.40	252.9±2.90	ns	***	***
	SD	35.59	38.25	59.38			
Protein percentage (%)	Average ± SEM	3.3± 0.01	3.3± 0.01	3.4±0.01	ns	***	***
	SD	0.28	0.29	0.24			

ns = p>0.05, p<0.05*, p<0.01**, p<0.001***

Table 7. Averages, dispersion indices and statistical significance for **maturity equivalent (ME) milk production** according to the **calving season**

Milk production indices	Statistics	Calving season		Significance
		Winter (n=365)	Summer (n=293)	
Milk yield (kg)	Average ± SEM	7175.9± 109.05	7060.8± 129.32	***
	SD	2083.48	2213.60	
Fat yield (kg)	Average ± SEM	292.1± 5.16	286.06± 5.72	***
	SD	98.67	98.01	
Fat percentage (%)	Average ± SEM	4.1± 0.01	4.0± 0.01	**
	SD	0.56	0.52	
Protein Yield (kg)	Average ± SEM	247.9± 1.63	237.6±1.78	**
	SD	62.65	63.72	
Protein percentage (%)	Average ± SEM	3.6± 0.01	4.3± 0.01	***
	SD	0.23	0.25	

ns = p>0.05, p<0.05*, p<0.01**, p<0.001***

4. Conclusions

There were no significant differences for real, normal and ME milk production indices between small and medium farms, except for protein percentage that was higher in medium farms. The highest values for milk production indices were obtained in large farms compared to small and medium farms.

Cows that calved in the winter season produced more milk yield, fat yield and protein yield than cows that calved during summer. Fat and protein percentages were higher in summer than in winter calving cows.

Milk production indices had a significant increase from first to second lactation, except for the total days in milk, which is decreasing with the age of cows. From second to third lactation the milk production indices decrease significantly. When compared to the first lactation, milk production indices were significantly lower in the third lactation.

References

1. Acatincăi S., Erina E.S. – Tehnologii zootehnice-Producțiile bovinelor. Ed. Eurobit, Timișoara, 2019.
2. Ensminger M.E., Perry R.C. - Beef cattle science. 7th Edition, Interstate publishers, INC Danville, Ilinois, USA, 1997
3. Stanciu G. - 1999, Tehnologia creşterii bovinelor. Ed. Brumar, Timişoara
4. Velea C., Mărginean Gh. – Tratat de creștere a bovinelor. Vol. I, Editura Risoprint, Cluj –Napoca, 2012
5. Acatincăi S., Marcu Adela, Cziszter L.T., Baul Simona, Ferencz Andreea, Găvojdean D., (2007) - Studiu privind influenţa sezonului calendaristic şi a ordinii lactaţiei asupra producţiei de lapte, a componentelor majore şi a numărului de celule somatice din lapte, Lucrări Stiintifice. Zootehnie şi Biotehnologii, vol. 40 (2), Timişoara, pp. 501-505.
6. Cadar Olezia, Velea C., Rebrişorean Ada (2008) - Indici ai producţiei cantitative şi calitative de lapte în faza maximă a curbei de lactaţie, Lucrări şt. Zootehnie şi Biotehnologii, vol. 41(2), Timişoara, pp. 362-367.
7. Gavojdian D., Stanciu G., Cziszter L.T., Acatincăi S., Tripon I., Baul Simona (2006) - Contribuţii la cunoaşterea unor indici morfologici şi productivi la vacile primipare din rasa Bălţată românească, Lucrări şt. Zootehnie şi Biotehnologii, vol. 39 (2), Timişoara, pp. 169-172.
8. Crişan Gabriela, (2006) - Cercetări comparative privind indicii producţiei de lapte la taurinele de rasă Bălţată cu negru crescute în fermele private din România şi Germania, Lucrări şt. Zootehnie şi Biotehnologii, vol. 39 (2), Timişoara, pp. 155-160.
9. Pop I., (2002) – Teză de doctorat "Cercetări privind unii factorii care influenţează producţia individuală de lapte şi efectul tehnico-economic al acestora în exploatarea taurinelor de tip Simmental", Cluj Napoca.