

PRODUCTION PERFORMANCES OF COWS OF DIFFERENT ORIGIN AND HOUSING METHOD

Dragan Nikšić¹, Vlada Pantelić¹, Dušica Ostojić-Andrić¹, Predrag Perišić², Ljiljana Samolovac¹, Miloš Marinković¹, Maja Petričević¹

¹Institute for Animal Husbandry, Autoput 16, 11080, Belgrade-Zemun, Republic of Serbia

²Faculty of Agriculture, Nemanjina 6, 11080, Belgrade-Zemun, Republic of Serbia

Corresponding autor: Dragan Nikšić, draganniksic84@gmail.com

Original scientific paper

Abstract: In order to examine the variability of production performance traits (lactation duration, milk yield for the whole lactation, milk yield in standard lactation, milk fat content, milk fat yield in standard lactation, protein content and yield in standard lactation), 954 cows, domestic and imported Simmental populations, were included in the study, with a total of 3641 completed lactations. Cows were located in the area of Toplica district, reared on individual farming households (tied system) and on the farm with intensive farming (free system). Based on the rearing method and origin, animals were divided into four groups: Group 1 (domestic animals reared by individual agricultural producers on individual farming households); Group 2 (imported animals reared by individual agricultural producers on individual farming households); Group 3 (domestic animals reared on the farm) and Group 4 (imported animals reared on the farm). The fourth group of studied cows showed the highest yield and protein content, while the cows of the third group had the longest lactation and the highest milk fat content. All production performance traits varied highly significantly ($p \leq 0.001$) under the influence of the combined factor of housing/rearing method and origin.

Keywords: breed, milk, milk fat, origin, Simmental farm

Introduction

Milk production has biological and production significance. Together with reproduction, it is the material basis for the maintenance of the species. In terms of production, in addition to being the highest quality human food, it also provides the basis for meat production through rearing calves. Milk yield is the most important feature of milk performance and is determined for the whole lactation, as well as for the standard 305 day lactation. Milk production in standard lactations, i.e. 305 day lactation, enables the mutual comparison of lactations of different duration.

Different genotypes of Simmental cows (domestic cows and Simmental cows imported from Germany and Slovenia), their production and reproductive traits, are examined by *Perišić (1998)*, in the region of upper flow of the Kolubara River. The study shows the average duration of the first three lactations of 307.18 days, in all animals included in the study, and the average milk yield for the duration of lactation of 4311.1 kg. The lowest milk yield is recorded in cows of Domestic spotted breed with production in the first three lactations of 3738.8 kg, 4033.4 kg and 4384.3 kg, respectively and the highest yield by cows of the German Simmental breed - 4120.4 kg, 4669.2 kg and 5153.2 kg. The study shows the average milk fat content for the whole lactation of 3.83%, for all animals included in the study, an average milk fat yield of 165.06 kg and 4191.17 kg of 4% FCM.

In the study of the major milk performance traits of F₁ daughters of the same Simmental bulls in Germany and Serbia, *Kučević et al. (2005)* have established significantly greater absolute difference in the quantity of milk produced of 1057 kg in the F₁ generation in Germany, the difference at the level of significance ($p \leq 0.05$). A statistically significant difference ($p \leq 0.01$) has been determined for milk fat and milk fat content, with daughters tested in Germany achieving higher production.

By comparing the three-year average of the best Simmental herd in our country and the average established for imported first calving heifers from Austria during 2004-2005, *Medić et al. (2006)* have determined the milk yield of 4472 kg for 305 days, for domestic animals, which is lower compared to imported animals by significant 1171 kg of milk. Austrian animals also had a significantly higher average milk fat content of + 0.49% and a total milk fat content of +73 kg. These differences of mean values are highly significant.

Pantelić (2006) states that the average duration of lactation in first calving Simmental heifers in Serbia is 311.72 days, with a minimum duration of 241 and a maximum of 586 days.

In the study of the production potential of first calving Simmental heifers calving in the period 2007-2010 in the individual sector in Serbia, *Nikšić et al. (2011)* have recorded the average milk yield of 4348 kg, 3.93% milk fat content and milk fat yield of 171.1 kg. With the exception of 2009, the milk yield of first calving heifers has been steadily increasing on average by about 100 kg of milk per head per year.

In the analysis of the phenotypic variability of Simmental bull dams, *Pantelić et al. (2013)* have determined the milk yield of 5754.49 kg, with 3.98% and 230.24 kg of milk fat, i.e. 5755.47 kg of 4% FCM.

In the study of the effect of the import of breeding animals of the Simmental breed from Germany on the implementation of the breeding program on the territory of the city of Kragujevac, *Kostić (2014)* has obtained the following production results in his research: the imported animals in all three lactations have achieved higher milk yield (449.08 kg in I, 568.52 kg in II and 488.73 kg in III),

milk fat (19.87 kg, 22.66 kg and 18.52 kg) and 4% fat corrected milk (477.64 kg; 567.26 kg and 473.36 kg). Domestic cows have recorded lower milk fat content in the first lactation by 0.05%, but the same trait in the second and third lactation has shown higher levels by 0.01% in each lactation.

The average production of all cows under control in Austria in 2012 (*Genetic Austria*) was 7073 kg of milk, 4.15% milk fat (293.53 kg), and 3.43% protein (242.60 kg), while the average production of first calving heifers was 6419 kg, with 4.13% milk fat (265.1 kg) and 3.40% protein (218.25 kg).

Materials and Methods

Basic data on production traits, as well as data on the origin of all the studied cows, were collected in collaboration with the “Lazar” Blace farm, which housed part of the cattle included in this study. For the animals that were reared on the households/farms of individual agricultural producers, data on the above performance traits were collected in cooperation with the breeding organizations, which are responsible for the implementation of the breeding program in the area of Toplica district. This study identified differences in the production traits of imported cows reared on the “Lazar” Blace farm and by individual agricultural producers, then differences in the milk performance traits between the imported and cattle of domestic origin on the farm, but also with individual agricultural producers of Simmental breed cows in the same area.

The total number of animals and their completed lactations is divided into four groups, with each group having approximately the same percentage of cows of different lactations by order, as follows:

Group 1: Domestic animals reared by individual agricultural producers on individual farming households (n = 1526);

Group 2: Imported animals reared by individual agricultural producers on individual farming households (n = 234);

Group 3: Domestic animals reared on the farm (n = 1100);

Group 4: Imported animals reared on the farm (n = 781).

When examining the impact of the unified factor of housing/rearing and origin, the model with fixed unified factor of housing/rearing and origin (NP) was used:

$$Y_{ij} = \mu + NP_i + e_{ij}$$

Y_{ij} : trait studied,

μ : population average for a given trait,

NP_i : fixed unified effect of housing/rearing and origin (i = 1,2,3,4)

e_{ij} : random error

The analyzed factors are combined/merged due to their interaction, because to the greatest extent their impact is reflected through the interaction of these two factors.

Subsequent to the variance analysis and determining the basic parameters of descriptive statistics by using the test of least significant differences (LSD), the differences between the groups were determined individually for all observed traits.

SPSS Statistics software for Windows, Version 23.0 was used for the statistical data processing and application of the said model.

Results and Discussion

In this study, the following milk performance traits were analyzed: lactation duration, whole and standard lactation milk yield, milk fat content and yield, and protein content and yield.

Table 1 shows the lactation duration of the observed cows divided into four groups. The shortest duration of lactation was recorded in cows of domestic origin reared by individual agricultural producers, 304.12 days. The imported cows reared by individual agricultural producers had an average lactation duration of 313.67 days, while slightly longer lactation time was recorded in cows of domestic origin reared on the farm, 323.96 days, and slightly longer in imported animals, 314.13 days. The results obtained are higher than the average lactation duration reported by *Perišić (1998)* and *Pantelić (2006)*, except for the first group of cows, where the duration of lactation is shorter compared to values obtained by these two authors. The combined housing/rearing and origin factor showed statistically very highly significant ($p \leq 0.001$) effect on the observed four groups of cows for the trait tested. If the milk yield values for the whole and standard lactation by groups are observed, as shown in Table 1, the lowest values were recorded in cows of domestic origin housed/reared on individual agricultural households/farms, slightly higher values were recorded in the second and third group of cows, and the highest in imported cows reared on the farm (Group 4). Milk yield values for the whole and standard lactation varied statistically very highly ($p \leq 0.001$) under the unified factor of housing/rearing method and origin of the animal. The obtained values for milk yield in all four groups were significantly higher than the values for first calving heifers in Serbia, as reported by *Nikšić et al. (2011)*. Groups of imported animals (3 and 4) achieved higher production than animals originating from Germany in the research of *Perišić (1998)* and bull dams in Serbia, cited in their research by *Pantelić (2013)*.

Table 1. Mean values and variability of milk yield traits by groups of cows

Trait	Group	Number of lactations	\bar{X}	SD	SE	95% confidence interval		Min.	Max.
						LB	UB		
Duration of lactation (days)	1	1526	304.12	39.096	1.001	302.15	306.08	200	563
	2	234	313.67	34.845	2.278	309.18	318.15	236	434
	3	1100	323.96	46.084	1.389	321.23	326.68	243	514
	4	781	314.13	19.382	0.694	312.77	315.49	256	412
Total		3641	312.87	38.851	0.644	311.61	314.13	200	563
		F=58.647***			p=0.000				
Milk yield whole lactation (kg)	1	1526	4817.57	1123.811	28.768	4761.14	4874.00	1877	13150
	2	234	5028.50	873.375	57.094	4916.01	5140.99	2610	7438
	3	1100	6181.03	1160.670	34.996	6112.37	6249.70	3050	13367
	4	781	6592.19	659.728	23.607	6545.85	6638.53	4273	9135
Total		3641	5623.71	1291.620	21.405	5581.74	5665.67	1877	13367
		F=663.926***			p=0.000				
Milk yield standard lactation (kg)	1	1526	4802.84	963.159	24.656	4754.48	4851.20	1289	9434
	2	234	4907.26	823.760	53.851	4801.17	5013.36	2609	7015
	3	1100	5872.75	928.905	28.008	5817.79	5927.70	3031	9643
	4	781	6437.63	590.128	21.116	6396.17	6479.08	4434	9000
Total		3641	5483.45	1106.311	18.334	5447.50	5519.40	1289	9643
		F=721.625***			p=0.000				
Milk fat content standard lactation (%)	1	1526	3.89	0.109	0.003	3.88	3.89	3.32	4.81
	2	234	3.92	0.079	0.005	3.91	3.93	3.69	4.17
	3	1100	3.94	0.131	0.004	3.93	3.94	3.53	4.91
	4	781	3.92	0.092	0.003	3.92	3.93	3.48	4.28
Total		3641	3.91	0.113	0.002	3.91	3.92	3.32	4.91
		F=42.177***			p=0.000				
Milk fat yield standard lactation (kg)	1	1526	187.22	39.968	1.023	185.21	189.22	47.95	403.56
	2	234	192.46	33.526	2.192	188.14	196.78	106.04	276.10
	3	1100	231.11	37.102	1.119	228.92	233.31	120.05	411.16
	4	781	252.56	22.846	0.817	250.96	254.17	172.91	360.97
Total		3641	214.83	44.789	0.742	213.38	216.29	47.95	411.16
		F=704.633***			p=0.000				
Milk protein content standard lactation (%)	1	1526	3.15	0.087	0.002	3.15	3.16	2.61	3.43
	2	234	3.15	0.074	0.005	3.14	3.16	2.87	3.36
	3	1100	3.16	0.088	0.003	3.16	3.17	2.95	3.93
	4	781	3.24	0.096	0.003	3.23	3.25	2.83	3.43
Total		3641	3.17	0.095	0.002	3.17	3.18	2.61	3.93
		F=176.346***			p=0.000				

Milk protein yield standard lactation (kg)	1	1526	151.44	30.685	0.786	149.90	152.99	40.86	297.31
	2	234	154.70	26.320	1.721	151.31	158.09	85.45	221.98
	3	1100	185.81	29.875	0.901	184.04	187.58	99.43	305.04
	4	781	208.57	20.779	0.744	207.11	210.03	144.51	298.27
Total		3641	174.29	36.559	0.606	173.10	175.48	40.86	305.04
		F=811.078***			p=0.000				

N=number; \bar{X} =average; SD=standard deviation; SE=standard mean error; LB= lower limit; UB=upper limit; F=statistical value; p=significance ***- $p \leq 0.001$; ** - $p \leq 0.01$; * - $p \leq 0.05$; nz - $p > 0.05$

Observing by groups (Table 1), the highest milk fat content was recorded in cows of domestic origin reared on the farm - 3.94%, 3.92% of milk fat content was recorded in imported animals reared on the farm and by individual agricultural producers, while the lowest content of milk fat was recorded in domestic cows reared by individual agricultural producers (3.89%). The values obtained are in the concordance with those obtained by *Nikšić et al. (2011)*, slightly lower than the milk fat content of bull dams in Serbia reported by *Pantelić et al. (2013)*, and by 0.10% higher in relation to the values obtained by *Perišić (1998)*. The influence of the factors of the housing/rearing method and the origin of the animals had statistically very high ($p \leq 0.001$) impact on the milk fat content of the four observed groups.

Table 1 also see shows the realized milk fat yields by groups based on origin and method of housing/rearing. The highest yields were obtained from imported cows on the farm (252.56 kg), followed by cows of domestic origin also on the farm (231.11 kg), imported cows reared by individual agricultural producers originating (192.46 kg), and the lowest yields were achieved by domestic cows reared by individual producers (187.22 kg). All four groups of cows achieved significantly higher milk fat production than those cited by *Perišić (1998)* and *Nikšić et al. (2011)*, while the milk fat production of bull dams cited by *Pantelić et al. (2013)* is the same as the third group of cows. The influence of these factors on the variability of milk fat yield of the observed population by groups was statistically very high ($p \leq 0.001$).

Looking at the population by groups, it can be concluded that the animals reared by individual agricultural producers had the same protein content (3.15%), regardless of their origin. Slightly higher values for protein content were obtained from farm-raised animals (3.16%), while a significantly higher percentage was obtained from farm-raised imported animals (3.24%). Protein content values obtained are significantly lower than the results reported in Austria for the entire examined population of cows and first calving heifers in their 2012 annual report. The effect of these two combined factors on the observed trait of the four groups of cows was statistically very highly significant ($p \leq 0.001$).

Table 1 also lists the milk protein yield values in the observed population divided into four groups. The lowest yield was achieved by cows of domestic origin reared by individual producers, 151.44 kg, which is 3.26 kg less than the yield of cows originating from import reared under the same conditions. The farm reared domestic animals had a protein yield of 185.81 kg, while under the same conditions the imported animals realized a yield of 208.57 kg. As for the protein content, the protein quantity was significantly lower than the results reported in Austria for the whole examined population of cows and first calving heifers in their 2012 annual report. Protein yield varied statistically very high significantly ($p \leq 0.001$) under the influence of the unified factor of rearing method and origin.

Table 2. Differences of averages for all examined traits by groups of cows (LSD test)

Duration of lactation	2	3	4	Milk yield whole lactation	2	3	4
1	-9.551***	-19.840***	-10.017***	1	-210.931**	-1363.467***	-1774.622***
2		-10.289***	-0.465 ^{nz}	2		-1152.536***	-1563.691***
3			9.824***	3			-411.155***
Milk yield standard lactation	2	3	4	Milk fat content	2	3	4
1	-104.423 ^{nz}	-1069.906***	-1634.784***	1	-0.0288***	-0.0469***	-0.0354***
2		-965.483***	-1530.361***	2		-0.0181*	-0.0066 ^{nz}
3			-564.878***	3			0.1154*
Milk fat yield	2	3	4	Milk protein content	2	3	4
1	-5.2448*	-43.8904***	-65.3441***	1	0.0015 ^{nz}	-0.0107*	-0.0854***
2		-38.6492***	-60.0993***	2		-0.0122 ^{nz}	-0.0869***
3			-21.4500***	3			0.0747***
Milk protein yield	2	3	4				
1	-3.2514 ^{nz}	-34.3674***	-57.1273***				
2		-31.1160***	-53.8759***				
3			-22.7600***				

Based on the test of the least significant difference (LSD, Table 2) it can be stated that the difference between the groups was statistically significant at different levels of significance ($p \leq 0.001$ *** to $p \leq 0.005$ *), in all examined traits, except between groups 1 and 4 for the trait lactation duration, 1 and 2 for the trait milk production in standard lactation, 2 and 4 for the milk fat content, 1 and 2 and 2 and 3 for the protein content, and 1 and 2 for the trait of protein yield, where no statistically significant differences were established ($p > 0.05$ nz).

Conclusions

Farm-reared cows (domestic and imported) achieved by 1614.34 kg higher yield than cows reared on individual agricultural households (domestic and imported), while imported animals (farm-reared and reared on individual agricultural households) produced by 1261.50 kg more milk compared to animals of domestic origin (farm-reared and reared on individual agricultural households).

All observed production performance traits varied very significantly ($p \leq 0.001$) under the influence of the combined factor of the rearing method and the origin of animals.

Based on the results obtained for production performance traits, it can be concluded that the yield of milk, milk fat and protein in the observed population was above the average of the whole population of cows of the Simmental breed in the Republic of Serbia.

From the results obtained by comparing cows by origin and method of rearing, it can be concluded that domestic cows can have significantly higher production if they are provided with favorable rearing conditions present on the studied farm. It can also be concluded that imported animals contribute significantly to the improvement of production on individual agricultural households, but at the same time that their potential is not utilized to the maximum of their potential in such rearing conditions.

Proizvodne performanse krava različitog porekla i metoda držanja

Dragan Nikšić, Vlada Pantelić, Dušica Ostojić-Andrić, Predrag Perišić, Ljiljana Samolovac, Miloš Marinković, Maja Petričević

Rezime

U cilju ispitivanja varijabilnosti proizvodnih osobina (trajanje laktacije, prinos mleka u celoj laktaciji, prinos mleka u standardnoj laktaciji, sadržaj mlečne masti, prinos mlečne masti u standardnoj laktaciji, sadržaj proteina i njegov prinos u standardnoj laktaciji) domaće i uvežene populacije krava simentalske rase, u ovom istraživanju obuhvaćeno je 954 krava, sa ukupno 3641 zaključenom laktacijom. Sve krave su se nalazile na području Topličkog okruga, kod individualnih poljoprivrednih proizvođača (vezani sistem) i na farmi sa intenzivnim načinom gajenja (slobodni sistem). Na osnovu načina držanja (vezani i slobodni sistem) i porekla (damaća grla, grla iz uvoza) grla su bila podeljena u četiri grupe: grupa 1 (grla domaćeg porekla, gajena kod individualnih proizvođača); grupa 2 (grla

poreklom iz uvoza, gajena kod individualnih proizvođača); grupa 3 (grla domaćeg porekla, gajena na farmi) i grupa 4 (grla poreklom iz uvoza, gajena na farmi). Četvrta grupa posmatranih krava ostvarila je najveće prinose i sadržaj proteina, dok je treća grupa imala najdužu laktaciju i najveći sadržaj mlečne masti. Sve proizvodne osobine vrlo visoko značajno ($p \leq 0.001$) varirale pod uticajem objedinjenog faktora načina držanja i porekla.

Ključne reči: rasa, mleko, mlečna mast, poreklo, farma krava simentalске rase

Acknowledgement

Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia No 451-03-68/2020-14/200022.

References

- GENETIC AUSTRIA (homepage on the internet) (2020). Hohenzell. Genetic Austria, GmbH, (cited on December 10, 2020). Available from: <http://www.genetic-austria.at/en/breeds-info/fleckvieh/892.html>
- KOŠTIĆ S. (2014): Efekat uvoza priplodnih grla simentalске rase na sprovođenje odgajivačkog programa na teritoriji grada Kragujevca. Master rad. Poljoprivredni fakultet, Lešak.
- KUČEVIĆ D., WAEHNER M., PETROVIĆ M.M., PANTELIĆ V. (2005): Ispitivanje osobina mlečnosti kćeri istih bikova simentalске rase u Nemačkoj i Srbiji. *Biotechnology in Animal Husbandry* 21, 1-2, 21-27.
- MEDIĆ D., VESELINOVIĆ S., VESELINOVIĆ S., IVANČEV A., ČUPIĆ Ž. (2006): Uredna ispitivanja osobina mlečnosti simentalskih krava domaće i austrijske provincijence. Simpozijum: Stočarstvo, veterinarstvo i agroekonomija u tranzicionim procesima, Herceg Novi, 142-150.
- NIKŠIĆ D., OSTOJIĆ-ANDRIĆ D., PANTELIĆ V., PERIŠIĆ P., NOVAKOVIĆ Ž., ALEKSIĆ S., LAZAREVIĆ M. (2011): Production potential of first calving Simmental heifers in Serbia. 3rd International Congress "New Perspectives and Challenges of Sustainable Livestock Production", Belgrade, October 5th to 7th, 2011, *Biotechnology in Animal Husbandry*, 27, 3, 1033-1043.
- PANTELIĆ V. (2006): Fenotipska i genotipska varijabilnost proizvodnih osobina prvotelki simentalске rase u različitim regionima Srbije. Doktorska disertacija. Poljoprivredni fakultet Beograd-Zemun.
- PANTELIĆ V., RUŽIĆ-MUSLIĆ D., PETROVIĆ M.M., NIKŠIĆ D., OSTOJIĆ-ANDRIĆ D., ALEKSIĆ S., LAZAREVIĆ M. (2013): The phenotypic variability of production traits in the population of Simmental cows. *Proceedings of the 10th*

International Symposium Modern Trends in Livestock Production, October 2-4, Belgrade, Serbia, 26-36.

PERIŠIĆ P. (1998): Reproduktivne i proizvodne osobine različitih genotipova krava simentalске rase. Magistarska teza. Poljoprivredni fakultet, Beograd.

Received 12 November 2020; accepted for publication 3 December 2020