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MILK PRODUCTION TRAITS OF SIMMENTAL COWS IMPORTED FROM AUSTRIA AND THEIR DAUGHTERS REARED IN SERBIA

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Abstract: The objective of this study was to examine the milk traits of Simmental cows imported from Austria and their offspring born on the P.D. "DMN" farm, located in the municipality of Požarevac in Serbia and to determine the statistical significance of the differences between the milk production results of mothers and daughters. After Germany, Austria is the second largest exporter of pregnant Simmental heifers in both Europe and worldwide. The research included a total of 409 cows with 572 lactations recorded from the beginning of the farm's operation in 2019 until the end of 2024. Production differences among animals in standard lactations were analyzed, along with comparisons of standard lactation results between mothers and daughters. By comparing the production results between mother cows and their daughters in the first and second standard lactations, a statistical significant difference in milk yield was found ($p<0.001$), while in the third lactation, the differences were not statistically significant ($p>0.05$). All the animals included in the research originated from the same farm, which enabled a precise comparison between mothers and daughters due to the combined influence of the farm and other environmental factors during the exploitation period.

Key words: dairy cows, milk production, milk traits, cattle import

Introduction

The production of cow's milk is primarily of biological importance (for raising offspring), as well as of economic importance (in the food industry for the

global population). Consequently, the total milk yield represents the most significant milk trait, determined both for the entire lactation period and for the standard lactation lasting 305 days. This standardization enables a reliable comparison of lactations of different durations.

The decrease in the number of livestock, the agricultural population, and the number of farms has been a decades-long trend in the Republic of Serbia. Aleksić et al. (2009) reported that the state of livestock production in Serbia is unfavorable, as the number of all types of domestic animals and poultry has been constantly decreasing. The largest decline in livestock numbers has been recorded since the early 2000s across all types of domestic animals.

Bogdanović et al. (2012) stated that approximately 59% of dairy farms in Serbia have up to 20 hectares of arable agricultural land available, with an average of about 10 hectares. On the other hand, about 55% of farms rear up to 15 head of cattle, with an average of 6 head per farm. Over 86% of surveyed farmers expressed an intention to expand existing production by increasing the number of animals, mainly through imports and stricter selection of parent pairs, as well as by improving nutrition, housing, and care conditions (Bogdanović et al., 2012). Sredojević et al. (2025) recommend that the rationalization of total milk production costs, based on proper planning of the quantity, quality, composition, and price of animal feed, should be improved in order to make farms economically profitable and to enable the economic sustainability of milk production. Given the limited capacity of animal organisms to adapt to the rapid pace of climate change, sustainable milk production remains a significant challenge in the context of global climate change (Mićić et al., 2025).

A large number of Simmental cattle have been imported from Germany and Austria over time, resulting in the Simmental breed comprising about 80% of the total cattle population in the country. Additionally, there has recently been a declining trend in the number of farmers keeping 1–3 dairy cows in Serbia (Perišić et al., 2012; Pantelić et al., 2021).

Popović (2014) cites data from the Statistical Office of the Republic of Serbia, based on the 2012 agricultural census, which indicates a total of 908,102 head of cattle in Serbia. However, at the beginning of 2025, according to the veterinary database, the total number of cattle was 714,730 head (https://cas.vet.minpolj.gov.rs/). Subić and Vasiljević (2022) state that despite favorable natural conditions for improved livestock production in the Republic of Serbia, the livestock sector is mostly characterized by a downward trend in the number of animals in the most important livestock categories. Between 2010 and 2019, the total number of cattle decreased annually at a rate of 0.43%.

The Republic of Serbia is among the European countries where the Simmental breed of cattle is well adapted and has been the most predominant breed for over a century. It has been used to improve domestic autochthonous cattle breeds, resulting in a significant replacement or crossbreeding of local cattle

populations with the Simmental breed. The breed has primarily spread through the importation of females, breeding stock, and breeding bull semen from Austria, Switzerland, and Germany. Based on the current status of Simmental cattle breeding in the Republic of Serbia, as well as organizational, technical, and economic capacities in livestock production, and in accordance with basic genetic principles, the breeding objective for a controlled population of the Simmental breed-with a maximum of 25% dairy breed genes-defines specific milk traits. These include a milk yield of over 5,500 kg per standard lactation, a minimum milk fat content of 4.00%, a minimum protein content of 3.40%, a protein-to-fat ratio of 1:1.15-1.20, an age at first insemination of 15-18 months, and an age at first calving of 24-27 months (MBP, 2019).

Freyer et al. (2008) state that the antagonism between the continuous increase in milk production and the decrease in productive lifespan, accompanied by declining fertility in cows, is an ongoing and growing problem in the global cattle industry. The same authors further suggest that crossbreeding dairy cattle breeds can be an effective strategy to improve the functional traits of heifers and cows.

Kučević et al. (2005) observed the most important milk yield traits of cows and their daughters from the same sires of the Simmental breed in Germany and Serbia. They reported a significantly greater absolute difference in milk production of +1,057 kg in the primiparous cow generation in Germany, with differences at a high level of significance ($p \leq 0.05$). A statistically highly significant difference ($p \leq 0.01$) was also found for milk fat quantity and milk fat content, with daughters tested in Germany showing higher production.

Ajili et al. (2007) report that cows with the highest milk production in early lactation, unlike those with average production, are utilized more intensively and are culled from the herd at a higher rate.

Stanojević et al. (2022) report results from their research indicating a milk yield of 5,520 kg in standard lactation, with a milk fat content of 3.94%.

The Simmental (Fleckvieh) breed accounts for 74.7% of the total cattle population in Austria, with a population of 1,397,682 head according to 2021 data. It is reared from the Alpine mountain regions to the lowlands in the east. In 2021, Austria had 313,658 cows bred on 12,020 farms, of which 73% operate under difficult working conditions. In 2023, milk production control was performed on 268,760 cows. Over a 305-day lactation, an average of 7,910 kg of milk was produced, containing 4.17% milk fat and 3.37% protein, totaling approximately 600 kg of fat and protein combined. Among 71,960 first-calving cows, an average production of 7,187 kg of milk with 4.16% milk fat and 3.37% protein was recorded (https://www.fleckvieh.at/zucht/fleckvieh).

The breeding program in Austria is based on genomic selection and aims to quickly and efficiently achieve the breeding objectives. The targeted use of young

bulls shortens the generation interval and enables faster and greater genetic progress in traits with low heritability.

The genomic selection program includes the selection of approximately 60 young bulls from around 4,000 candidates each year (selection ratio of 1:60). From these genomically selected bulls, the best six are annually chosen based on progeny testing of their offspring. Regarding insemination proportions, the goal is that 75% of registered cows in Austria be inseminated by young bulls, while for bull dams the target proportion is 90%. If applied consistently, this breeding program can achieve approximately 10% genetic progress per year, with a tendency toward greater robustness (https://www.genetic-austria.at/en/fleckvieh-simmental/fleckvieh-info-13571.html). Thanks to these efforts, Austria is one of the largest exporters of genetic material, with more than 23,000 Simmental cattle exported annually. Simmental genetic material from Austria is also sold as bull semen or in the form of frozen embryos (https://www.fleckvieh.at/zucht/fleckvieh/). Thus, pregnant heifers imported to Serbia, along with their genetic background, influence the improvement of selection effects even after calving through their female offspring. Furthermore, the study presents the production data of the first three lactations of mothers and daughters under Serbian production conditions.

Materials and Methods

Material – Farm

The research for this study was conducted at the dairy farm of the agricultural holding "DMN" Veliko Crnićе, located in the municipality of Požarevac, Serbia (44°33′13″ N, 21°17′05″ E). Both mothers and daughters achieved milk production in their own first three lactations on the same farm under the same conditions of management, feeding plan and technological procedures.

The farm was reconstructed in 2018, when 130 pregnant Simmental heifers were imported from Austria. In 2019, an additional 60 cows were imported, followed by another 30 cows in 2022. Currently, the farm has close to 600 cows of all categories, with plans to reach 600 cows by 2026 and 1,000 cows including their progeny thereafter.

All animals are kept in a free-stall system, distributed by category across six facilities. The buildings are oriented in an east-west direction to align with the prevailing wind. The sides are not fully walled, allowing for good ventilation and natural lighting. Additionally, the buildings are equipped with wind protection nets used during adverse weather conditions.

Feed for all animals on the farm is prepared as a Total Mixed Ration (TMR) tailored separately for each category. The advantages of TMR include increased dry matter intake, leading to higher milk production and improved

average daily gain in calves. Additionally, TMR promotes optimal rumen fermentation by providing a consistent diet with every bite, preventing sudden and frequent stresses on rumen microflora and eliminating selective feeding.

Milking is performed twice daily, with the milk collected in a 6,000-liter milk collector (Lactofreeze). The cows are divided into five groups based on production and stage of lactation: the first group includes cows producing more than 30 liters; the second, 25-30 liters; the third, 20-25 liters; the fourth group consists of cows in the pre drying period; and the fifth group includes dried-off cows. The third facility has a capacity of 80 stalls and uses a milking robot for cow milking. The milk is transported to a dedicated milk collector with a capacity of 4,000 liters. Cows have access to the milking robot up to three times within 24 hours. Through the software, various milking parameters can be monitored individually for each cow, as well as for each quarter of the udder.

Method – Data processing

During data collection, a total of 572 completed lactations up to August 2024 were analyzed. Production results were determined through regular milk yield control (AT4 control). Milk yield data of cows are recorded daily. By entering the number of a cow, all relevant data can be accessed, including daily milk yield, cumulative milk yield from the beginning of lactation until a specific day, and data from all previous lactations. In addition to these, data related to veterinary interventions-such as insemination dates, calving dates, treatments, and therapies-are also recorded.

The milk yield control analyzed the following milk yield properties:

- Days of lactation (days)
- Milk yield in standard lactation (kg)
- Milk fat yield in standard lactation (kg)
- Milk fat content in standard lactation (%)
- Milk protein yield in standard lactation (kg)
- Milk protein content in standard lactation (%)

To examine differences in milk production between mothers and daughters, as well as across individual lactations, the T-test procedure in the SAS statistical package was used (SAS Institute Inc., 2011). Descriptive statistics were calculated using the MEANS procedure, while the T-test procedure was employed to examine statistically significant differences between the analyzed animal groups within the same statistical package.

Results and Discussion

According to the main breeding program for Simmental cattle in Central Serbia (MBP, 2019), the breeding objective for a controlled population-with a

maximum of 25% dairy breed genes-is defined as follows: a milk yield of over 5,500 kg in standard lactation, a minimum milk fat content of 4.00%, and a minimum milk protein content of 3.40%. In their research, Mićić et al. (2022) report an average daily milk fat content of 4.04% and a protein content of 3.23% for the examined population of cows in Central Serbia.

Table 1 compares the production results of cows from the first import and their daughters in the first standard lactation.

A statistically highly significant difference ($p<0.001$) was found in all examined production parameters, except for protein content in standard lactation, where a statistical highly significant difference was observed ($p<0.01$).The established milk production on the farm-over 8,000 kg for first-calving mothers and over 7,000 kg for first-calving daughters-is significantly higher than the production reported for individual producers in Central Serbia by Nikšić et al. (2011). Examining the production potential of Simmental heifers in Serbia, Nikšić et al. (2011) report an average milk yield of 4,348 kg with 3.93% milk fat and a milk fat yield of 171.1 kg, which is significantly lower than the cows in the present study. The milk production determined in standard lactation was also higher compared to the results reported by Stepić et al. (2018), who found an average yield of 6,659.9 kg of milk with 4.09% milk fat and 3.40% protein.

It is interesting to note (Čačić et al., 2022) that Simmental cows calving female calves in their first and second lactations had higher milk yield than those calving male calves, although the differences were not statistically significant. In the same study, the milk yield of first-lactation cows was recorded as 4,630.98 kg for mothers of male calves and 4,639.91 kg for mothers of female calves.

According to the report and results from the breeding program control in 2023 (Report, 2023), a sample of 14,824 first-calving cows in Central Serbia showed an average milk production of 4,973 kg in standard lactation, with 3.99% milk fat and 3.20% protein content. Considering these results, we can conclude that the animals examined in this study significantly exceed the average milk yield of the first-calving cows in Central Serbia. The milk yield determined in standard lactation was also higher compared to the results obtained by the aforementioned authors. Pantelić et al. (2013) report a significantly higher milk fat yield in first-calving Simmental cows in Serbia. Stanojević et al. (2022) report a milk yield of 5,052 kg with a milk fat content of 3.92% for first-calving cows.

Nikšić et al. (2023), examining both imported and domestic populations of Simmental cows, state that the origin of the cows has no statistically significant effect ($p>0.05$) on the milk fat content of first-lactation cows. However, housing conditions and their interaction with cow origin are statistically highly significant difference ($p\leq0.001$). The domestic cow population shows a fat content of 3.94%, while imported cows have a slightly lower milk fat content of 3.92%.

Table 1. Comparison of cows and their daughters in the first standard lactation

Traits	Mothers		Daughters		$t^{(p)}$
	Mean	Std.Error	Mean	Std.Error	
Milk yield in standard lactation (kg)	8143.1	117.6	7127.8	133.9	5.65^{***}
Milk fat content in standard lactation (%)	4.17	0.01	4.04	0.01	8.67^{***}
Milk fat yield in standard lactation (kg)	339.3	4.65	288.2	5.39	7.15^{***}
Protein content in standard lactation (%)	3.38	0.005	3.35	0.007	3.15^{**}
Protein yield in standard lactation (kg)	274.9	3.79	238.9	4.49	6.12^{***}
N	112		79		

*** ($p<0.001$), ** ($p<0.01$), * ($p<0.05$), ^{ns} ($p>0.05$)

Table 2 compares the production results of cows from the first import and their daughters in the second lactation. Milk yield traits in a standard 305-day lactation were examined. Statistically highly significant differences ($p< 0.001$) were found in all analyzed milk production parameters.

Table 2. Comparison of cows and their daughters in the second standard lactation

Traits	Mothers		Daughters		$t^{(p)}$
	Mean	Std.Error	Mean	Std.Error	
Milk yield in standard lactation (kg)	8633.3	123.1	7830.3	220.6	3.41^{***}
Milk fat content in standard lactation (%)	4.13	0.007	4.04	0.01	7.53^{***}
Milk fat yield in standard lactation (kg)	356.2	4.93	315.9	8.80	4.28^{***}
Protein content in standard lactation (%)	3.40	0.003	3.34	0.01	9.10^{***}
Protein yield in standard lactation (kg)	293.3	4.15	261.6	7.35	4.02^{***}
N	93		42		

*** ($p<0.001$), ** ($p<0.01$), * ($p<0.05$), ^{ns} ($p>0.05$)

Stanojević et al. (2022) report lower values for cows in the second lactation, as shown in Table 2, with an average milk yield of 5,553 kg and a milk fat content of 3.94%.

Table 3 compares the production results of cows from the first import and their daughters in the third lactation. No statistically significant difference ($p>0.05$) was found in milk yield in standard lactation trait. For the next four examined milk traits, statistically significant difference were found ($p<0.001$; $p<0.05$).

By comparing the milk yield in standard lactation between imported cows and their daughters across the first and second lactations, statistically highly significant difference were found ($p<0.001$), while in the third lactation, no statistically significant differences were observed ($p>0.05$). The lack of statistical

significance may be related to the relatively small number of animals in the sample, which can increase the standard error. Therefore, increasing the sample size might lead to statistically significant results.

Table 3. Comparison of cows and their daughters in the third standard lactation

Traits	Mothers		Daughters		$t^{(p)}$
	Mean	Std.Error	Mean	Std.Error	
Milk yield in standard lactation (kg)	8926.1	174.4	8064.0	514.3	1.92^{ns}
Milk fat content in standard lactation (%)	4.08	0.008	4.01	0.02	3.66^{***}
Milk fat yield in standard lactation (kg)	363.8	6.78	323.3	21.02	2.29^{*}
Protein content in standard lactation (%)	3.41	0.004	3.32	0.01	8.14^{***}
Protein yield in standard lactation (kg)	304.0	5.85	267.4	16.96	2.44^{*}
N	69		14		

*** ($p<0.001$), ** ($p<0.01$), * ($p<0.05$), ^{ns} ($p>0.05$)

Stanojević et al. (2022) report a milk yield of 5.703 kg with 3.96% milk fat in cows completing their third lactation, while in this study, both mothers and daughters produced more than 8,000 kg of milk and more than 4.00% milk fat content.

For the trait milk fat content in standard lactation, across all observed lactations-first, second, and third-the differences between mothers and daughters were statistically highly significant difference ($p<0.001$). Although this study focuses on examining the milk production traits of mothers and their daughters, the potential effect on statistical significance may stem from differences in rearing conditions during the heifer phase. The mothers were raised as heifers in Austria before calving, whereas the daughters were raised on the farm in Serbia.

Conclusions

By comparing the milk production results in the first, second, and third lactations between imported cows and their daughters in Serbia, statistically significant differences were found in the examined production parameters, except for milk yield in the third standard lactation, where no statistically significant difference was recorded. This result of the comparison in the third lactation should be considered with caution given the very small sample size and large statistical error. The obtained results can serve as a basis for further research related to the importance of heifer rearing and its correlation with milk production traits, but also with other important traits from the breeding goals that effect on milk production (for example, type traits, age at first insemination, body condition).

Based on the analysis of completed lactations of Simmental cows on the studied farm, it is evident that the milk yield in a standard lactation is well above the national average in the Republic of Serbia. When compared with results from other authors, a higher milk yield in standard lactation was observed, while the milk fat and protein contents are consistent with levels reported by other studies. If other farms were to improve their production conditions to the level of those on the studied farm, the average milk production in Serbia would likely be higher.

Osobine mlečnosti krava simentalske rase uvezenih iz Austrije i njihovih ćerki odgajenih u Srbiji

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Rezime

Cilj ovog rada je bio da se ispitaju proizvodni rezultati krava simentalske rase uvezenih iz Austrije i njihovog potomstva rođenog na farmi P.D. "DMN" koja se nalazi u opštini Požarevac. Posle Nemačke, Austrija je drugi najveći izvoznik steonih junica simentalske rase u Evropi i svetu. Istraživanjem je obuhvaćeno ukupno 409 krava koje su ostvarile 572 laktacije u periodu od početka rada farme 2019. godine do kraja 2024. godine za osobine mlečnosti u standardnoj laktaciji. Upoređene su razlike u proizvodnji između grla u standardnim laktacijama i upoređivani su rezultati proizvodnje majka – ćerka u standardnim laktacijama. Upoređivanjem rezultata proizvodnje između krava majki i njihovih ćerki u prvoj i drugoj standardnoj laktaciji utvrđena je statistički značajna razlika ($p<0,001$) u prinosu mleka, dok u trećoj laktaciji razlike nisu bile statistički značajne ($p>0,05$). Sva grla obuhvaćena istraživanjem su sa iste farme, i u tom smislu, precizno poređenje majki sa ćerkama bilo je moguće, zbog zajedničkog uticaja farme i drugih faktora životne sredine u toku eksploatacije.

Ključne reči: krave, proizvodnja mleka, osobine mlečnosti, uvoz goveda

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Conflict of interest
The authors declare no conflict of interest.

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