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Comparison of longevity and production traits of Holstein and Simmental cows of different origin in Slovenia

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Summary

The aim of this research was to establish whether there are differences in the longevity and production characteristics within the studied breeds of cows of different origin. Holstein cows of Slovenian (461) and foreign (356) origin and Simmental cows of Slovenian (261) and foreign (43) origin were studied. Only culled animals that previously had between 1 and 9 lactations were included. The analyzed properties consisted of characteristics related to the longevity and lifetime productivity. Compared with Slovenian cows, imported Holstein cows had a significantly longer calving interval (1210±31 days, 1337±39 days, P=0.008), a longer dry period (172±6 days, 192±7 days, P=0.022), and a significantly lower daily milk yield (23.0±0.2 kg, 22.0±0.3 kg, P=0.002). Significant differences between Simmental cows of Slovenian and foreign origin were observed in functional productivity (1317±52 days, 1808±186 days, P=0.006), longevity (2175±53 days, 2701±145 days, P=0.004), and duration of lifetime lactation (990±38 days, 1265±137 days, P=0.037).

Key words: cows, Holstein breed, Simmental breed, production properties, longevity

Introduction

For milk production from milk and/or dual-purpose breeds of cattle, longevity is an important factor for cost efficient breeding. A cow's lifespan can be divided into a non-productive phase and a productive phase interrupted by short non-productive dry periods (Essl, 1998). Longevity is defined as the number of calving or the time spent by an animal in the herd. Relevant to longevity properties is whether the cow lives for a certain number of months or years (Vollema and Groen, 1996) or successive calvings (Hare et al., 2006). The generation interval can be prolonged by exploiting traits defining whether a cow lives a fixed number of months, e.g., at least 36 months (Vollema and Groen, 1997; VanRaden et al., 2006), 48 months (Essl, 1998; Vollema and Groen, 1998), or even 60 months (Garcia-Peniche et al., 2006), as well as insights into the relevant cost-effectiveness of the properties that are thereby enhanced. The characteristics defining longevity include those that are countable (lactations, years) and those which are partly continuous (days, months) (Garcia-Peniche et al., 2006). Such traits, however, are affected by a number of factors, including fertility, reproduction, weight gain, the animal's overall health, and its age.

Most analyses that have examined the duration of the productive life of cows have been based on incomplete information, in that some of the studied animals were still living at the conclusion of the study, while the others had already been removed. In an earlier work, Janžekovič et al. (2004) compared milk production between imported first-calving cows and first-calving cows of Slovenian origin. The production and longevity properties of those cows were followed until the animals' removal from the

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herd. The aim of the present study was to establish whether Holstein and Simmental heifers imported from the EU had better lifetime productive properties and better longevity than cows of the same breeds but of Slovenian origin.

Material and methods

The animals used in the study were pregnant heifers of the Holstein or Simmental breed that had been bought abroad and pregnant heifers of the same breeds but of Slovenian origin that in 1999-2000 were calving for the first time. The study comprised 461 cows of Holstein breed of Slovenian origin and 356 imported cows, and 261 pregnant heifers of Simmental breed of Slovenian origin and 43 imported cows.

Only breeders having one of the two breeds on their farm participated in the study. The studied cows had already had 1-9 consecutive calving and were always bred on farms together with cows of Slovenian origin. This information was obtained from the central cattle-breeding data base at the Agricultural Institute of Slovenia (http://www.govedo.si) and by using the computer application for tracing animals, VOLOS, together with the central cattle registry data base at the Slovenian Ministry of Agriculture, Forestry and Food (https://storitve-mkgp.gov.si/dad/sir/Volos).

Longevity and milk production characteristics

For estimations of longevity and milk production characteristics, the following traits were investigated:

- Number of consecutive calving
- Age at first calving (months)
- Functional productivity, i.e., the number of days from the first calving to culling
- Longevity, i.e., the number of days from birth to culling
- Lactation, i.e., the number of days when the cow was in lactation
- Longevity index, defined as the ratio between the number of days when the animal is in lactation divided by its total life span (from birth to culling) (Haworth et al., 2008)
- Calving interval (days)
- Dry period (days)
- Milk yield per milking day (kg)
- Lifetime milk yield (kg)
- Lifetime protein yield in milk (kg)
- Lifetime fat yield in milk (kg)

Statistical analysis

Variance analysis was performed using the GLM procedure (SPSS 15.0 for Windows) with the following statistical model:

$$Y_{ijkl} = \mu + O_i + CS_{ij} + B_{ijk} + e_{ijkl}$$

where Y is the studied characteristic of the l-th cow of i-th origin (i = 1, 2, 3, 4), of j-th calving season (CS) (j = 1, 2, 3, 4), and k-th breeder (B) (k = 1,……, 121) and e_{ijkl} is the remaining variance. Differences between means were tested with the post-hoc Duncan multiple range test and were defined as being statistically significant at $P<0.05$. All values indicated in Tables 1 and 2 are the LSM (least square means) ± SEM.

Pearsons´ correlation coefficients were estimated between production and longevity characteristics. A significant relationships between two traits was declared at $P<0.05$.

Results and discussion

The production and longevity properties for the individual breeds and different origins are described in Tables 1 and 2. Cows of Holstein breed had an average of 3.6 calving before they were removed from herd. There were no significant differences between Holsteins of foreign and Slovenian origin ($P^3 0.05$) (Table 1).

In a previous study of first calving American Holstein cows 2.8-3.2 parities (Hare et al., 2006) and an age of 1503 days (Garcia-Peniche et al., 2006) were reported, while in another study Slovenian Holstein cows had 3.59 lactations (Jenko et al., 2007). The longevity of the Holstein cows of this study was 29-70 % greater than that of the American Holsteins.

On average, upon culling from the herd, Holstein cows followed in another study had a productive life of 24.6±12.7 months (VanRaden et al., 2006) whereas for the two groups of cows in our study functional productivity lasted as long as 47 months, without significant differences with respect to origin. A slightly shorter functionally productivity

Table 1: Comparison of productivity and longevity characteristics of Holstein cows among origins
Tablica 1: Usporedba karakteristika produktivnosti i dugovječnosti holstein krava različitog podrijetla

	Slovenia Slovenija	Imported Uvoz	P-value P-vrijednost
N	461	356	
Parities/Redovna teljenja	3.6±0.1	3.6±0.1	0.815
Age at 1st calving (months)/Starost kod prvog teljenja (mjeseci)	28.9±0.2	28.8±0.2	0.681
Functional longevity (days)/Funkcionalni životni vijek (dani)	1425±34	1424±43	0.930
Longevity (days)/Životni vijek (dani)	2291±34	2290±43	0.978
Lactation (days)/Laktacija (dani)	1225±28	1237±37	0.703
Longevity index/Indeks životnog vijeka	0.50±0.01	0.49±0.01	0.165
Calving interval (days)/Interval teljenja (dani)	1210±31	1337±39	0.008
Dry period (days)/Suhostaj (dani)	172±6	192±7	0.022
Mean daily yield/Srednja vrijednost dnevnog prinosa (kg)	23.0±0.2	22.0±0.3	0.002
Lifetime milk yield/Prinos tijekom cijeloga životnog vijeka (kg)	28857±739	27912±933	0.471
Fat yield/Prinos masti (kg)	1206±31	1229±41	0.602
Protein yield/Prinos proteina (kg)	965±24	960±32	0.960

period, 45.5 months, was reported for the Holstein breed by Jenko et al. (2007). Differences between studies regarding productivity are likely due to differences in farm management practices. This is confirmed in the literature, where it was shown that breeders' decision and farm management criteria explain most of the variability in the productive life of Holstein-Friesian cows in New Zealand (Berry et al., 2005). Of the five different reasons for variable productivity that were stated by Weigel et al. (2003), the most important was the number of cows per farm employee, with a lower probability that a cow would be "involuntarily" removed on family farms having a smaller number of cows per family member employed on the farm.

The farms included in our study had a relatively small number of cows compared to farms of comparable size that are located in Western Europe and in the USA. Thus, the Slovenian farms probably exploit their cows for longer periods of time and subject them to less intensive breeding. Farms with breeding systems of medium intensity have also been shown to have a smaller share of removed cows than is the case on farms with more intensive systems (Hanson et al., 1998). In decisions regarding when to remove a cow from the herd, consecutive lactation and relative milk production as well as the protein and fat content of the milk are also important (Chirinos et al., 2007). The average lifetime milk yield of Slovenian Holstein cows was reported to be 26.395 kg (Jenko et al., 2007). In the cows in our study, the lifetime yield was slightly higher, with imported cows having an insignificantly smaller yield than Slovenian ones.

Heifers, which typically give birth to their first calf at an age of 22-23 months, are known to have good milk production, fewer fertility problems, and a high probability that they will not need to be removed from the herd within the first 5 years of life (Wathes et al., 2008). The heifers in our study had their first calf at an average age of 29 months. This is 5-7 months higher than reported for cows in Britain (Wathes et al., 2008) and the USA (van Amburgh et al., 1998) but comparable to the accepted optimal age of 2-2.5 years for cows in Australia (Haworth et al., 2008). Data form the present study has shown that first calving season had significant effect on production charactersitics, but not in relation to calving interval. Nutritive supply of cows in spring and summer time has significant effect on milk production and it reduces also a possible calves health problems. The Pearsons correelation coefficient between some production and longevity traits are presented in Table 3.

Table 2: Comparison of productivity and longevity characteristics of Simmental cows among origins
Tablica 2: Usporedba karakteristika produktivnosti i dugovječnosti simentalskih krava različitog podrijetla

	Slovenia/Slovenija	Imported/Uvoz	P-value/P-vrijednost
N	261	43	
Parities	3.4±0.1	3.7±0.4	0.392
Age at 1st calving (months) Starost kod prvog teljenja (mjeseci)	30.2±0.5	29.7±0.5	0.265
Functional longevity (days) Funkcionalni životni vijek (dani)	1317±52	1808±186	0.006
Longevity (days)/Životni vijek (dani)	2175±53	2701±145	0.004
Lactation (days)/Laktacija (dani)	990±38	1265±137	0.037
Longevity index/Indeks životnog vijeka	0.43±0.01	0.45±0.03	0.457
Calving interval (days) Interval teljenja (dani)	1250±52	1351±186	0.552
Dry period (days)/Suhostaj (dani)	314±24	357±82	0.586
Mean daily yield (kg) Srednja vrijednost dnevnog prinosa (kg)	16.5±0.2	16.6±0.5	0.920
Lifetime milk yield (kg) Prinos tijekom cijeloga životnog vijeka (kg)	17169±792	21519±2639	0.109
Fat yield (kg)/Prinos masti (kg)	739±35	904±114	0.168
Protein yield (kg)/Prinos proteina (kg)	601±28	762±95	0.092

The age at first calving is thought to affect a cow's longevity. The older is the heifer at first calving, the greater its functional longevity (Table 3, r=0.134, P≤0.01). Haworth et al. (2008) found that cows producing less than 30 L milk/day in the first lactation and with an age of less than 2 years at first calving live 3.6 years on average, while cows with a first calving at 2-3 years of age tend to survive for 4.7 years, and those more than 3 years old at first calving have an average longevity of 5.8 years. By contrast, studies on the influence of daily milk yield on longevity suggest that Holstein cows producing more than 30 L milk/day in the first lactation do not survive for more than two lactations (Haworth et al., 2008) and thus pose a significant economic loss to the breeder. The cows in the present study lived an average of 6.3 years, without significant differences between the groups. A reason this long life might be that the milk production at the first lactation was relatively low and the cows were a few months older at first calving. Correlation coeffcients between mean milk daily yield and longevity, as well as with subsequent parity were moderate, but highy signficant (r=0.232, r=0.279, P≤0.01). Imported cows had significantly less milk per milking day than cows of Slovenian origin (22 vs. 23 kg, P=0.002).

One of the most important reasons for the removal of milking cows is problems with teat health, as udder and teats properties are considered to be important indicators of longevity (Vukašinovic et al., 1995; Bouška et al., 2006). Therefore, the improvement of production quality and of teat health is important for extending longevity (Sewalem et al., 2006). The lifetime functional productivity per individual breeding-bull is already being noted in bull catalogues, together with productive properties (Vukašinovic et al., 2001; Forabosco et al., 2009). It was previously reported that Holstein cows with correct development of the foot angle, udder fixation, and teat position, with a strong central ligament, and with slightly longer teats have a longer functional period (Mrode et al., 2000; Vacek et al., 2006).

For cows 48 months of age, the time between calving accounted for ~30 % of the total lifetime and was equal to 14 months (Oltenacu and Algers, 2005). It is well-established that the time between two calving increases with the cow's age. On

average, cows are around 76 months old at culling, with the time between two calving being 40-44.6 months, i.e., 53-59 % of the cow's lifetime. Jenko et al. (2007) stated that Holstein cows are typically removed at an age of 74.5 months, which is a few months less than the age reached by the cows in our study. In a study by the Hanover Chamber of Agriculture, Brade (2005) reported that cows of Holstein breed were removed at an age of 62.5 months.

Studies on the longevity of dual-purpose breeds, crossbreds with meat breeds, and meat breeds are less frequent in the literature than for milk breeds. The production results and several of the characteristics describing longevity are presented in Table 2.

Cows of the Chianina breed that calved before 35 months of age had a lower probability of being removed than cows of the same breed those calved later (Forabosco et al., 2004). Similarly, heifers of the Brown Swiss breed those were older than 3 years at first calving had a greater probability of early removal from the herd (Bielfeldt et al., 2006). Nonetheless, opinions about the influence of calving age differ greatly; for example, the age at first calving had no significant influence on the longevity of the Slovakian Pinzgau breed (Mészáros et al., 2008). For cows of milk and meat breeds, fertility and the size of the herd determine the probability of removal, since cows producing at least one calf annually remain in the herd longer (Forabosco et al.,

Table 3: Pearsons´ correlation coefficients between characteristics of production and longevity of the cows
Tablica 3: Pearsonovi korelacijski koeficijenti između produktivnosti i dugovječnosti krava

	O	AFC	FL	LN	CI	DP	L	P	LMY	FY	PY	MDY	IL
O	1	-0.66	0.008	0.018	-0.086*	-0.095*	0.013	0.021	0.046	0.012	0.032	0.082*	0.103**
AFC		1	0.134**	-0.01	0.042	0.036	-0.007	-0.023	-0.002	-0.005	-0.008	0.037	-0.188**
FL			1	0.990**	0.927**	0.758**	0.966**	0.917**	0.910**	0.896**	0.909**	0.235**	0.795**
LN				1	0.940**	0.769**	0.976**	0.928**	0.919**	0.904*	0.918*	0.232**	0.829**
CI					1	0.823**	0.944*	0.965**	0.876**	0.852**	0.870**	0.165**	0.776**
DP						1	0.701**	0.785**	0.634**	0.610**	0.625**	0.087*	0.492**
L							1	0.931**	0.944*	0.931*	0.945**	0.244**	0.887**
P								1	0.898**	0.879**	0.894**	0.279**	0.804**
LMY									1	0.979**	0.993**	0.495**	0.838**
FY										1	0.984**	0.470**	0.832**
PY											1	0.480**	0.845**
MDY												1	0.255**
IL													1

*Statistically significant (P≤0.05)/Statistički signifikantan (P≤0,05); **Statistically significant (P≤0.01)/Statistički signifikantan (P≤0,01); O=origin of the cows/izvor krava; AFC=age at first calving/starost kod prvog teljenja; FL=functional longevity (days from birth to culling)/funkcionalna dugovječnost (dani od rođenja do izlučenja); LN=longevity (days from first calving to culling)/dugovječnost (dani od prvog poroda do izlučenja); CI=days between two subsequent parities/dani između dvaju poroda; DP=dry period in days/dani suhostaja; L=lactation in days/dani laktacije; P=parities/redovna teljenja, LMY=lifetime milk yield (kg)/količina proizvedenog mlijeka u životu (kg), FY=fat yield (kg)/količina proizvedene mliječne masti u životu (kg); PY=protein yield (kg)/količina proizvedenoga mliječnog proteina u životu (kg); MDY=mean daily yield (kg)/količina mlijeka na muzni dan (kg), IL=index of longevity/indeks dugovječnosti

2004) whereas cows with difficulties in calving or needing assistance are removed earlier (Szabó and Dákay, 2009). Dákay et al. (2006) studied the longevity properties in a population of Hungarian meat and crossbreed cows; the average age at first calving was 2.72 years, and the age at removal 9.47 years. For heifers of the Hungarian Simmental breed, the age at first calving was 2.64 years (Dákay et al., 2006). Similar data were obtained for this breed in the present study, with the average age of Simmental heifers at first calving being 30 months (Table 2). Cows of the dual-purpose Pinzgau breed were 35.18 months old at first calving and 3.32 years old at culling; on average, they had 3.19 calving and their lifetime milk production was 9765 kg (Mészáros et al., 2008). The productive life of Simmental breed cows in Hungary was 7.9 years, with longevity determined in large part by the difficulty of calving (Szabó and Dákay, 2009). Imported Simmental cows were 7.4 years old at culling while those of Slovenian origin were 5.96 years (P=0.004). The differences were likely due to the fact that the imported Simmental heifers were more expensive than Slovenian ones and thus were kept significantly longer for functional production (P=0.006) and lactation (P=0.037), although there were no significant differences in milk yield. This was evident from the standard error, which is a few-fold greater than the mean of the studied property. Despite the longer use of Simmental cows of foreign origin a decision made by breeders cows in their productive period of life did not produce significantly higher quantities of milk than Slovenian Simmental cows, nor was the milk higher in fat or in protein.

Conclusions

Comparisons of the longevity and production results obtained with imported cows vs. those of domestic (Slovenian) origin provide important information for breeders of milk and of dual-purpose breeds.

The origin of the Holstein cows in this study did not result in differences in the number of calving, the age at first calving, functional productive longevity, longevity, duration of lactation, or longevity index. While imported Holstein cows had a significantly longer calving interval, a longer dry period, and significantly smaller daily milk yield, there were no significant differences between imported and Slovenia cows regarding lifetime milk yield or the fat and protein content of the milk. Imported Simmental cows were characterized by a small sample size and by high variability in the properties studied. Breeders kept imported Simmental cows significantly longer in production and in lactation, such that the cows had a significantly longer longevity. Significant differences in the other studied properties were not detected at least in part due to the wide variability of the data on the imported cows.

Usporedba dugovječnosti i proizvodnih svojstava holstein i simentalskih krava različitog podrijetla

Sažetak

Cilj rada bio je utvrditi postoje li razlike u dugovječnosti i proizvodnim karakteristikama između pasmina krava različitog podrijetla. Proučavane su holstein krave slovenskog (461) i stranog (356) podrijetla i simentalske krave slovenskog (261) i stranog (43) podrijetla. Samo krave koje su imale između 1 i 9 laktacija bile su uključene u istraživanje. Analizirana svojstva čine karakteristike vezane za dugovječnost i životnu proizvodnju. U usporedbi sa slovenskim kravama, uvezene holstein krave imale su značajno dulji interval između teljenja (1210±31 dana, 1337±39 dana, P=0,008), dulji suhostaj (172±6 dana, 192±7 dana, P=0,022), i značajno niži prinos mlijeka dnevno (23,0±0,2 kg, 22,0±0,3 kg, P=0,002). Statistički značajne razlike zabilježene su između krava slovenskoga i stranog podrijetla u promatranju funkcionalne produktivnosti (1317±52 dana, 1808±186 dana, P=0,006), dugovječnosti (2175±53 dana, 2701±145 dana, P=0,004) i u trajanju životne laktacije (990±38 dana, 1265±137 dana, P=0,037).

Ključne riječi: krava, holstein pasmina, simentalska pasmina, proizvodna svojstva, dugovječnost

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