Carcass traits of Holstein, Simmental and Brown Swiss calves, bulls and heifers and their crossbreeds with Charolais, Limousin, and Belgian Blue in Slovenia

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Abstract

The effects of crossing Holstein (HOL), Simmental (SIM) and Brown Swiss (BS) cows with Charolais (CHA), Limousin (LIM) and Belgian Blue (BB) sires on growth and carcass traits were evaluated. The crossbred animals were compared with purebred HOL, SIM and BS animals. A total of 174,365 calves, 397,962 bulls younger than 24 months and 160,731 heifers slaughtered in Slovenian abattoirs between 2009 and 2022 were included in the comparison. Carcass weight was determined within 45 minutes of slaughter. Net daily gain was calculated on the basis of carcass weight and age at slaughter. The conformation and fatness of the carcass were evaluated according to the EUROP classification system and divided into 15 subclasses. The most popular breed for crossbreeding was LIM, as their crossbreeds in all three categories of slaughtered cattle represented 72 %, crossbreeds with BBP 18 % and with CHA 10 % of all crossbreeds. The CHA breed increased carcass weight the most (by an average 10 % in all three categories of slaughtered cattle, followed by BBP with 8 % and LIM with 6 %). The CHA breed increased carcass weight by 10 kg for calves, 40 kg for young bulls and 17 kg for heifers, while the BBP breed increased carcass weight by 8, 40 and 16 kg and the LIM breed by 9, 19 and 4 kg in the three categories of slaughtered cattle. Net daily gain was also improved by crossbreeding, with the highest value again achieved by the CHA breed, which was 15 % or 71 g/day higher than the average of all three categories in purebred cattle. The most significant improvement in carcass conformation for all three categories was achieved by the BBP breed (42 % or 2.4 subclasses), followed by the CHA and LIM breeds (31 % and 1.8 subclasses). The BBP breed achieved slightly lower values (-4 % and -0.3 subclasses), while the crosses with the CHA (+3 % and +0.1 subclasses) and LIM (+5 % and +0.3 subclasses) breeds showed a higher carcass fatness than the purebred animals. The improvement of all carcass traits through crossbreeding was more pronounced in Holstein dairy cattle than in Brown Swiss and Simmental cattle.

Keywords: crossbreeding, Holstein, Simmental, Brown Swiss, beef breeds, carcass traits.
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Introduction

In the last ten years, the number of cows and cattle as whole in Slovenia has been relatively stable, but the proportion of different breeds has changed considerably. The number of dual-purpose cows of the Simmental (SIM) and Brown Swiss (BS) breeds decreased, while the number of dairy cows of the Holstein (HOL) breed and beef cows of the Charolais (CHA), Limousin (LIM) and other beef breeds increased (Sadar *et al*., 2024). Crossing of dairy and dual-purpose breeds with beef breeds can significantly improve both growth and carcass traits of fattening animals as well as beef production. The positive effects of crossbreeding differ depending on the dam and sire breeds used (Keane and Drennan, 2008; McGee *et al*., 2008, Huuskonen *et al*., 2014, Eriksson *et al*., 2020, Bittante *et al*., 2021). In Slovenia, the CHA, LIM and Belgian Blue (BBP) breeds have recently been used to cross SIM, BS and HOL. Therefore, the aim of our study was to investigate the effects of crossing our dual-purpose and dairy breeds (SIM, BS, HOL) with beef breeds (CHA, LIM, BBP) on growth rate and carcass traits in the entire Slovenian cattle population.

Material and methods

The study included records of animals of three different breeds, Holstein (HOL), Simmental (SIM), Brown Swiss (BS) and their crosses with Charolais (CHA), Limousin (LIM) and Belgian Blue (BBP), slaughtered in Slovenian abattoirs from 2009 to 2022. Three different categories of slaughtered animals were considered: young bulls aged 12 to 24 months (A), heifers aged more than 12 months without calving (E) and calves aged less than 8 months (V). A total of 174,365 calves, 397,962 young bulls and 160,731 heifers were included in the comparison (Table 1).

The data included hot carcass weight (HCW), net daily gain (NDG), carcass conformation and fat content. Hot carcass weight was measured within 45 minutes after slaughter. Net daily gain was calculated on the basis of carcass weight and age at slaughter. The carcass conformation and fatness of the carcass was assessed according to the EUROP classification system (The Commission of the European Communities, 2008) and divided into 15 subclasses.

Table 1. Number of animals of different breeds or crossbreeds and different categories included in the study.

Breed	A	E	V
SIM	258 269	101 583	42 430
SIM/BBP	5 228	3 614	1 369
SIM/CHA	4 144	2 544	897
SIM/LIM	23 108	16 022	7 711
BS	28 589	8 758	11 383
BS/BBP	2 431	1 628	1 028
BS/CHA	1 212	672	377
BS/LIM	10 628	7 500	5 182
HOL	57 458	14 116	98 061
HOL/BBP	2 139	1 297	1 572
HOL/CHA	607	322	392
HOL/LIM	4 149	2 675	3 963
Total	397 962	160 731	174 965

A - Young bulls, aged 12 to 24 months
E - Heifers, aged more than 12 months with no calving recorded
V - Calves, animals aged less than 8 months

Data were analyzed separately for each category (A, E, Z) of slaughtered animals using the GLM procedure of SAS (2002), where breed was included as a fixed effect and differences between breeds were tested using the PDIFF option.

Results and discussion

Young bulls of the SIM breed and its crosses had the highest HCW and NDG compared to young bulls of the HOL and BS breeds. The greatest improvement in HCW and NDG was achieved in all three breeds by crossing animals with CHA breed. The improvement

Table 2: Carcass traits (LSM±SE) of Holstein (HOL), Simmental (SIM) and Brown Swiss (BS) young bulls (A) and their crosses with Charolais (CHA), Limousin (LIM) and Belgian Blue (BBP).*

Breed	Hot carcass weight (kg)	Net daily gain (g/d)	EUROP conformation (1 – 15)	EUROP fatness (1 – 15)
SIM	367.1±0.1 ^{a}	566.1±0.2 ^{a}	8.63±0.00 ^{a}	6.34±0.00 ^{a}
SIM/BBP	379.9±1.0 ^{b}	589.7±1.4 ^{b}	10.26±0.03 ^{b}	5.58±0.03 ^{b}
SIM/CHA	382.0±1.1 ^{b}	598.0±1.5 ^{c}	9.57±0.03 ^{c}	6.26±0.03 ^{c}
SIM/LIM	361.9±0.5 ^{c}	564.6±0.7 ^{d}	9.33±0.01 ^{d}	6.23±0.01 ^{c}
BS	319.5±0.4 ^{a}	488.5±0.6 ^{a}	6.43±0.01 ^{a}	6.13±0.01 ^{a}
BS/BBP	359.7±1.4 ^{b}	551.1±2.0 ^{b}	8.97±0.04 ^{b}	5.71±0.04 ^{b}
BS/CHA	368.6±2.0 ^{c}	565.5±2.9 ^{c}	8.53±0.06 ^{c}	6.23±0.06 ^{ac}
BS/LIM	343.6±0.7 ^{d}	529.8±1.0 ^{d}	8.35±0.02 ^{d}	6.34±0.02 ^{c}
HOL	314.3±0.3 ^{a}	491.1±0.4 ^{a}	5.07±0.01 ^{a}	6.16±0.01 ^{a}
HOL/BBP	359.6±1.5 ^{b}	549.2±2.1 ^{b}	8.51±0.04 ^{b}	5.79±0.04 ^{b}
HOL/CHA	370.2±2.8 ^{c}	568.8±4.0 ^{c}	7.89±0.08 ^{c}	6.47±0.08 ^{c}
HOL/LIM	351.0±1.1 ^{d}	534.5±1.5 ^{d}	7.82±0.03 ^{c}	6.44±0.03 ^{c}

*A - young bulls, aged 12 to 24 months
LSM - Least square means; SE - standard error; ^{ab} LSM within breed of cows without the same superscript differ significantly (P<0.05)

Table 3. Carcass traits (LSM±SE) of Holstein (HOL), Simmental (SIM) and Brown Swiss (BS) heifers (E) and their crosses with Charolais (CHA), Limousin (LIM) and Belgian Blue (BBP).*

Breed	Hot carcass weight (kg)	Net daily gain (g/d)	EUROP conformation (1 – 15)	EUROP fatness (1 – 15)
SIM	278.5±0.2 ^{a}	391.6±0.3 ^{a}	7.68±0.01 ^{a}	7.73±0.01 ^{a}
SIM/BBP	294.2±1.0 ^{b}	439.8±1.5 ^{b}	9.43±0.03 ^{b}	7.24±0.04 ^{b}
SIM/CHA	292.4±1.2 ^{c}	433.2±1.7 ^{c}	8.65±0.4 ^{c}	7.92±0.05 ^{c}
SIM/LIM	275.2±0.5 ^{c}	404.9±0.7 ^{d}	8.42±0.02 ^{d}	7.78±0.02 ^{d}
BS	249.8±0.7 ^{a}	326.1±0.9 ^{a}	5.89±0.02 ^{a}	7.65±0.03 ^{a}
BS/BBP	269.3±1.6 ^{b}	403.4±2.2 ^{b}	7.93±0.05 ^{b}	7.21±0.07 ^{b}
BS/CHA	270.1±2.4 ^{b}	406.7±3.4 ^{b}	7.35±0.08 ^{c}	7.59±0.11 ^{a}
BS/LIM	258.6±0.7 ^{c}	380.1±1.0 ^{c}	7.52±0.03 ^{d}	7.91±0.04 ^{c}
HOL	262.4±0.5 ^{a}	347.3±0.7 ^{a}	4.69±0.02 ^{a}	7.45±0.02 ^{a}
HOL/BBP	276.7±1.7 ^{b}	409.2±2.4 ^{b}	8.00±0.06 ^{b}	7.11±0.08 ^{b}
HOL/CHA	278.3±3.5 ^{b}	415.0±4.9 ^{b}	7.35±0.11 ^{c}	7.73±0.15 ^{a}
HOL/LIM	268.6±1.2 ^{c}	395.3±1.7 ^{c}	7.43±0.04 ^{c}	8.08±0.05 ^{c}

* E - Heifers, aged more than 12 months with no calving recorded
LSM - Least square means; SE - standard error; ^{ab} LSM within breed of cows without the same superscript differ significantly (P<0.05)

in HCW was 4 % and NDG 6 % for the SIM breed, 15 % and 16 % for the BS breed, 18 % and 16 % for the HOL breed. Crossbreeding SIM cows with LIM sires resulted in a lower carcass weight and a slightly lower net daily gain. The best conformation was achieved in animals crossed with the BBP breed. The most significant improvement in carcass conformation for all three breeds was achieved with the BBP breed, followed by the CHA and LIM breeds. Young bulls derived from a cross with the BBP breed had the lowest fatness scores.

Crossing SIM, BS and HOL cows with CHA, LIM and BBP sires resulted in higher HCW, NDG and EUROP conformation in heifers, with the exception of crossing SIM cows with LIM sires, which resulted in lower carcass weight of SIM/LIM crosses compared to purebred SIM heifers. The most significant improvement in HCW and NDG in all three breeds was achieved with the CHA and BBP breeds. For carcass conformation, the most significant improvement was achieved with the BBP breed. Heifers from the SIM and BBP crosses had the highest conformation with, 9.43 on the scale from 1 to 15 EUROP. The heifers from the cross with the BBP breed had the lowest fatness scores.

Crossbreeding was also found to improve the calves. Crossbreeding SIM, BS and HOL cows with the CHA, LIM and BBP breeds resulted in better HCW, NDG and EUROP conformation of the calves. In the SIM breed, the greatest improvement in HCW and NDG was achieved with the CHA breed, while in the BS and HOL breeds the improvement was the same for all crosses. The most significant improvement in carcass conformation for all three breeds was achieved with the BBP breed.

The CHA breed increased carcass weight the most. The improvement was 10 % for all categories of slaughtered cattle, followed by BBP with 8 % and LIM with 6 %. The CHA breed increased carcass weight by 10 kg in calves, by 40 kg in young bulls and by 17 kg in heifers, while the BBP breed increased carcass weight by 8, 40 and 16 kg and the LIM breed by for 9, 19 and 4 kg in all three categories of slaughtered cattle. Crossbreeding also improved NDG, the highest was achieved with CHA breed and it was 15 % higher than the average of all three categories in purebred animals. The greatest improvement in carcass conformation was achieved in all three categories with the BBP breed, followed by the CHA and LIM breeds. The cross with the BBP breed resulted in a slightly lower carcass fatness (-4 % and -0.3 subclass), while the crosses with CHA (+3 % and +0.1 subclass) and LIM (+5 % and +0.3 subclass) breeds had a higher carcass fatness than the purebred animals.

Table 4. Carcass traits (LSM±SE) of Holstein (HOL), Simmental (SIM) and Brown Swiss (BS) calves (V) and their crosses with Charolais (CHA), Limousin (LIM) and Belgian Blue (BBP).*

Breed	Hot carcass weight (kg)	Net daily gain (g/d)	EUROP conformation (1 – 15)	EUROP fatness (1 – 15)
SIM	101.6±0.1 [a]	714.3±0.8 [a]	7.54±0.01 [a]	4.43±0.01 [a]
SIM/BBP	110.9±0.6 [b]	805.8±4.5 [b]	9.36±0.05 [b]	4.36±0.04 [a]
SIM/CHA	116.2±0.8 [c]	779.7±5.6 [c]	8.72±0.06 [c]	4.45±0.05 [a]
SIM/LIM	113.9±0.3 [d]	763.5±1.9 [d]	8.81±0.02 [c]	4.58±0.02 [b]
BS	94.3±0.2 [a]	690.8±1.6 [a]	6.24±0.02 [a]	4.08±0.01 [a]
BS/BBP	105.7±0.7 [b]	799.1±5.2 [b]	8.63±0.06 [b]	4.21±0.05 [b]
BS/CHA	104.9±1.2 [b]	797.6±8.6 [b]	8.10±0.10 [c]	4.25±0.08 [b]
BS/LIM	104.6±0.3 [b]	772.4±2.3 [c]	8.16±0.03 [c]	4.48±0.02 [c]
HOL	96.6±0.1 [a]	618.0±0.5 [a]	5.14±0.01 [a]	3.91±0.00 [a]
HOL/BBP	100.9±0.6 [b]	705.6±4.2 [b]	8.11±0.04 [b]	4.11±0.03 [b]
HOL/CHA	101.4±0.6 [b]	712.9±8.4 [b]	7.27±0.09 [c]	4.27±0.07 [c]
HOL/LIM	101.0±0.6 [b]	672.3±2.6 [c]	7.46±0.03 [c]	4.40±0.02 [c]

* V - Calves, animals less than 8 months old
LSM - Least square means; SE - standard error; [ab] LSM within breed of cows without the same superscript letter differ significantly (P<0.05)

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