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A comparison of the growth and carcass traits between dairy and dairy × beef breed crossbred heifers reared for beef production

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ABSTRACT. The objective of the study was to determine beef production traits of dairy and dairy × beef breed crossbred heifers. The data from Finnish slaughterhouses included observations of 14 221 Nordic Red (NR), 6 348 Holstein-Friesian (Hol), 1 626 NR × Aberdeen Angus (NR × Ab), 1 136 NR × Blonde d'Aquitaine (NR × Ba), 802 NR × Charolais (NR × Ch), 487 NR × Hereford (NR × Hf), 3 699 NR × Limousin (NR × Li), 827 NR × Simmental (NR × Si), 531 Hol × Ab, 467 Hol × Ba, 438 Hol × Ch, 186 Hol × Hf, 1 249 Hol × Li and 393 Hol × Si heifers. Crossbreeding with late maturing beef breeds (Ba, Ch, Li, Si) had favourable effects both on daily carcass gain and carcass quality traits (conformation, proportion of high value joints) of the progeny when compared to purebred dairy heifers. No advantages in proportion of high value joints seemed to be obtained by crossbreeding dairy cows with Ab or Hf breeds, while the improvements in daily carcass gain and carcass conformation score were intermediate compared to the late maturing crossbreds.

Introduction

Traditionally the majority of beef in Finland has been produced by dairy breeds, and Nordic Red (NR) and Holstein-Friesian (Hol) are the two most frequently used breeds. The population structure of the Nordic Red dairy cattle is an admixture of Finnish Ayrshire, Danish Red and Swedish Red populations (Makgahlela et al., 2013). In addition, the gene pool of each of these three populations constitutes fractions from other breeds. The decrease in the number of dairy cows has reduced the number of dairy bred calves available for beef production in Finland and while the beef cow herd has increased (Karhula and Kässi, 2010), this is not sufficient to offset the fall in dairy cow number. Because the supply of domestic beef has been decreasing, there is nowadays a clear discrepancy between the demand for and supply of domestic beef. Consequently, slaughterhouse pricing favours heavy carcasses and the average carcass weights of slaughtered animals have clearly increased in Finland during recent years (Karhula and Kässi, 2010). However, the current situation is complicated because fatness generally increases with higher carcass weight (Keane and Allen, 1998) and, on the other hand, market demand concerning carcass fat is different from those beef markets where marbled beef is favoured. Consumers generally favour low-fat products in Finland, and the Finnish beef industry has stated that optimally two thirds of the carcasses would have a EUROP fat score of 2 and one third a EUROP fat score of 3 (Herva et al., 2011). High-fat carcasses cause a lot of expenditures for the meat industry; lean carcasses are favoured in the pricing and there are penalties for fat carcasses. For these reasons, carcass fat score is an important production parameter affecting the profitability of farms and the entire beef chain.

Dairy heifers are mainly raised for replacement but also for slaughter. Approximately 10–15% of Finnish beef originated from heifers, including both dairy and beef breeds (Information Centre of the Ministry of Agriculture and Forestry, unpublished data). Beef production could be increased by developing profitable production systems to utilize ‘non-replacement’ heifer calves and by encouraging dairy farmers to increase the use of selected beef breed sires. Currently beef breed semen is used only in 6% of the dairy cow inseminations in Finland. There is a clear possibility to increase usage of beef breed semen for crossbreeding in dairy cows. Crossbreeding between dairy cows and beef-breed bulls has improved carcass production compared to pure dairy breeds in several experiments during many decades (e.g., More O’Ferrall and Keane, 1990; Aass and Vangen, 1998; Keane and Allen, 2002; Huuskonen et al., 2013). Generally, proportions of hind quarter and/or proportions of hind quarter lean or muscle tissue are higher for beef crosses than for purebred Friesians so crossbreds have produced more valuable carcasses (Keane et al., 1989; Keane, 1994).

The number of experimental animals is often limited when growth and carcass characteristics of different breed groups are compared (usually not more than dozens of animals per breed group). Consequently, there is a concern about the representativeness of the experimental animals compared with other animals from the same breed groups, i.e. whether they cover the whole variation in their respective populations. In addition, breed comparisons are mainly relevant for their specific production conditions and genetic level. Furthermore, relative to bulls and steers, much less dairy × beef crossbreeding trials has been carried out with heifers. Therefore, the main objective of the present research based on a large dataset collected from Finnish slaughterhouses was to study the potential for improvement of growth and carcass characteristics through dairy × beef breed crossbreeding compared to purebred dairy heifers. The second objective was to evaluate carcass fat score in relation to carcass weight in different breed groups. It was hypothesized that the use of beef breed crossbreeding improves carcass production compared to purebred dairy heifers. Furthermore, it was hypothesized that production traits improve more by using late maturing (Continental) beef breeds compared to early maturing (British) breeds.

Material and methods

Dataset – complete slaughter data

Dataset used in the present study was collected from four Finnish slaughterhouses: A-Tuottajat Ltd. (P.O. Box 908, FI-60061 Atria, Finland), HK-Agri Ltd. (P.O. Box 50, FI-20521 Turku, Finland), Saarioinen Lihanjalostus Ltd. (P.O. Box 108, FI-33101 Tampere, Finland) and Snellman Lihanjalostus Ltd. (Kuusisaarentie 1, FI-68600 Pietarsaari, Finland). These slaughterhouses are major meat companies in Finland, which, as a part of their business operations, transfer calves from dairy farms, or suckler cow herds, to co-operating farms for fattening and slaughter the animals. A raw slaughter data for each animal included individual animal identification number on ear tag, date of birth, date of slaughter, sex, carcass weight, carcass conformation score (EUROP) and carcass fat score (EUROP). Identities of breeds (dam and sire breed) were collected from the National Animal Identification Register for Cattle (ProAgria Agricultural Data Processing Centre, P.O. Box 25, FI-01301 Vantaa, Finland). Slaughtering data and identities of breeds for individual animals were linked through individual animal identification numbers on ear tags. All purebred Nordic Red (NR) and Holstein-Friesian (Hol) heifers as well as NR × beef-breed and Hol × beef-breed crossbred heifers slaughtered by above-mentioned slaughterhouses in 2009–2011 were selected for the study but the animals slaughtered under 240 or above 600 days of age were excluded.

In all slaughterhouses the carcasses were weighed hot after slaughter and the cold carcass weight was estimated as 0.98 of the hot carcass weight. The carcasses were classified for conformation and fatness using the EUROP quality classification (EC, 2006). For conformation, development of carcass profiles, in particular the essential parts (round, back, shoulder), was taken into consideration according to the EUROP classification (E – excellent, U – very good, R – good, O – fair, P – poor), and for fat cover degree the amount of fat on the outside of the carcass and in the thoracic cavity was taken into account using a classification range from 1 to 5 (1 – low, 2 – slight, 3 – average, 4 – high, 5 – very high). Each level of the conformation scale was subdivided into three sub-classes (e.g., O+, O, O–) to produce a transformed scale ranging from 1 to 15, with 15 being the best conformation.

Birth weight assumptions used in calculations were 40 kg liveweight and 16 kg carcass weight for calves, since the same values were used by A-Tuottajat Ltd. in daily extension work (Herva et al., 2009, 2011). The same birth weight assumptions for all genetic groups were used because there were not inclusive national statistics available, and according to Åkerlind et al. (2011), there are not considerable differences in birth weights between dairy and dairy × beef breed heifers in Danish, Norwegian and Swedish national recording data. An estimated daily carcass gain was calculated by subtracting 16 kg birth carcass weight from the reported slaughter weight and dividing the result by age at slaughter. The complete final slaughter data comprised 32 410 slaughtered heifers, the average slaughter age was 485 days, the mean carcass weight 215 kg and the estimated daily carcass gain 415 g · d^{-1} (Table 1). The average carcass conformation score was 4.0 (O–) and carcass fat score 2.9.

Dataset – commercial cutting

For estimating valuable cuttings for studied breed groups a separate dataset was collected in 2010–2011 from Snellman Lihanjalostus Ltd. In addition to above-mentioned variables this dataset included also information of commercial cuttings. Each carcass was cut into valuable cuts: outside round (*Musculus semitendinosus*), inside round (*Musculus semimembranosus*), corner round (*Musculus quadriceps femoris*), roast beef (*Musculus gluteus medius*), tenderloin (*Musculus psoas major*) and loin (*Musculus longissimus*) and subcutaneous fat as described by Manninen et al. (2011) and Pesonen et al. (2012). All these cuttings were weighed automatically in line and their yields were expressed as percentages of the carcass cold weight (0.98 × carcass hot weight, 50 min post-mortem). This dataset comprised 1 716 slaughtered heifers (Table 1). The mean carcass weight was 218 kg, EUROP conformation score 4.3 and fat score 3.0.

Table 1. Description of the experimental data

Indices	n	Mean	Std	$q_{0.05}$ [a]	$q_{0.95}$ [b]
Dataset, complete slaughter data					
age at slaughter, d	32 410	485	71.2	363	588
carcass gain, g · d^{-1}	32 410	415	85.3	274	551
carcass weight, kg	32 410	215	41.6	142	278
conformation score [c]	32 367	4.0	1.46	2	7
fat score [d]	32 405	2.9	0.88	2	4
Dataset, commercial cutting					
carcass weight, kg	1 716	218	36.1	160	277
conformation score [c]	1 716	4.3	1.29	3	7
fat score [d]	1 716	3.0	0.88	2	4
From yield, %					
subcutaneous fat	1 696	6.2	2.12	3.2	10.1
Musculus longissimus [e]	1 648	4.0	0.49	3.4	4.7
Musculus psoas major [f]	1 651	1.5	0.14	1.3	1.7
Musculus semimembranosus [g]	1 664	4.1	0.44	3.5	4.8
Musculus semitendinosus [h]	1 677	5.9	0.61	5.1	6.9
Musculus quadriceps femoris [i]	1 670	3.8	0.34	3.4	4.4
Musculus gluteus medius [j]	1 676	1.8	0.21	1.5	2.2

[a] 0.05-quantile (approximately 5% of the data has a value less than the 0.05-quantile); [b] 0.95-quantile (approximately 95% of the data has a value less than the 0.95-quantile); [c] conformation: (1 − poorest, 15 − excellent); [d] fat cover: (1 − leanest, 5 − fattest); [e] loin; [f] tender loin; [g] inside round; [h] outside round; [i] corner round; [j] roast beef

Statistical analysis

The results are shown as least squares means. The normality of residuals and the homogeneity of variances were checked using graphical methods: box-plots and scatter plots of residuals and fitted values. The data were subjected the analysis of variance using the SAS Mixed procedure (version 9.2, SAS Institute Inc. Cary, NC). The model used was:

$$y_{ij} = \mu + \alpha_i + e_{ij}$$

where: μ − the overall mean, e_{ij} − the random error term, α_i − the fixed effect of breed group. Age at slaughtering was not taking into consideration in the final statistical model because the effect was quantitatively minimal. Differences between the breeds were compared using Dunnett's test so that purebred dairy group was used as a control breed group.

Results

The complete slaughter data included 14 221 purebred NR heifers (Table 2) and 6 348 purebred Hol heifers (Table 3). The most popular beef breed sires were Limousin (Li) (3 699 and 1 249 observations, NR and Hol crossbreds, respectively), Aberdeen Angus (Ab) (1 626 and 531 observations) and Blonde d'Aquitaine (Ba) (1 136 and 467 observations). Charolais (Ch), Hereford (Hf) and Simmental (Si) sires were used less (Tables 2 and 3). The average slaughter ages for purebred NR and Hol heifers were 492 and 486 days, respectively. With all crossbred groups (except Hol × Hf) the average slaughter age was slightly, but significantly, lower than that with purebred heifers (Tables 2 and 3).

The average carcass weight of the purebred Hol heifers (208 kg) was 3% higher and the estimated daily carcass gain (399 g · d^{-1}) 5% higher than those of the pure NR heifers (202 kg, 381 g · d^{-1}) ($P < 0.01$ and $p < 0.05$ for carcass weight and carcass gain, respectively). All compared crossbred groups differed significantly ($P < 0.001$) from pure dairy heifers in both carcass weight and carcass gain

Table 2. Carcass gain, carcass characteristics and valuable cuts of purebred Nordic Red (NR) and NR × beef breed crossbred heifers in Finnish slaughter dataset (Ab - Aberdeen Angus, Ba - Blonde d'Aquitaine, Ch − Charolais, Hf − Hereford, Li − Limousin, Si − Simmental)

	Breed group							SEM[a]
	NR×NR	NR×Ab	NR×Ba	NR×Ch	NR×Hf	NR×Li	NR×Si	
Dataset, complete slaughter data								
n	14 221	1 626	1 136	802	487	3 699	827	
age at slaughter, d	492	478***	471***	470***	477***	477***	481***	3.2
carcass gain, $g \cdot d^{-1}$	381	443***	468***	489***	458***	461***	466***	3.5
carcass weight, kg	202	226***	234***	242***	232***	233***	237***	1.8
conformation [c]	3.4	4.7***	5.9***	5.5***	4.6***	5.7***	4.9***	0.05
fat score [d]	2.7	3.6***	2.5***	2.9***	3.8***	2.9***	3.1***	0.04
Dataset, commercial cutting								
n	751	104	59	21	20	185	72	
carcass weight, kg	208	234***	234***	253***	227 [O]	238***	235***	7.5
conformation [c]	3.8	5.1***	6.0***	6.0***	4.9***	6.0***	5.1***	0.20
fat score [d]	2.9	3.7***	2.6*	3.0	4.0***	3.1*	3.3**	0.19
From yield, %								
subcutaneous fat	6.2	8.1***	4.7***	5.8	8.8***	6.2	6.3	0.47
M. longissimus [e]	3.9	3.9	4.7***	4.2**	3.7	4.4***	4.2***	0.09
M. psoas major [f]	1.5	1.4*	1.7***	1.6	1.4	1.6***	1.6***	0.03
M. semimembranosus [g]	4.0	3.9	4.6***	4.2	3.6***	4.4***	4.2**	0.09
M. semitendinosus [h]	5.7	5.7	6.8***	6.4***	5.8	6.4***	6.1***	0.11
M. quadriceps femoris [i]	3.8	3.6***	4.1***	3.9	3.7	4.0***	3.7	0.07
M. gluteus medius [j]	1.7	1.8	2.1***	1.9**	1.6	1.9***	1.9***	0.05

[a] SEM - standard error of mean (complete slaughter data: n = 487; commercial cutting: n = 20); [b] differences between the breed groups were compared using Dunnett's test so that purebred NR was used as a control breed; *** ($P < 0.001$), ** ($P < 0.01$), * ($p < 0.05$), [O]($p < 0.10$); [c] conformation: (1− poorest, 15 − excellent); [d] fat cover: (1− leanest, 5 − fattest); [e] loin; [f] tender loin; [g] Inside round; [h] outside round; [i] corner round; [j] roast beef

Table 3. Carcass gain, carcass characteristics and valuable cuts of purebred Holstein-Friesian (Hol) and Hol × beef breed crossbred heifers in Finnish slaughter dataset. (Ab - Aberdeen Angus, Ba - Blonde d'Aquitaine, Ch - Charolais, Hf - Hereford, Li - Limousin, Si - Simmental)

	Breed group							SEM[a]
	Hol×Hol	Hol×Ab	Hol×Ba	Hol×Ch	Hol×Hf	Hol×Li	Hol×Si	
Dataset, complete slaughter data								
n	6 348	531	467	438	186	1 249	393	
age at slaughter, d	486	471***	469***	464***	478	476***	473**	5.2
carcass gain, $g \cdot d^{-1}$	399	441***	480***	503***	455***	469***	468***	5.5
carcass weight, kg	208	221***	238***	246***	231***	237***	235***	2.8
conformation [c]	3.0	4.5***	5.7***	5.5***	4.5***	5.6***	4.7***	0.07
fat score [d]	2.7	3.3***	2.5***	3.0***	3.7***	3.0***	3.1***	0.06
Dataset, commercial cutting								
n	368	24	25	13	6	46	22	
carcass weight, kg	211	223***	241***	249***	229	238***	223	13.9
conformation [c]	3.3	4.9	6.0***	5.5***	4.5**	5.5***	4.8***	0.34
fat score [d]	2.9	3.5**	2.7	3.4	4.3***	3.2*	3.0**	0.34
From yield, %								
subcutaneous fat	5.9	7.9**	4.3***	6.5	8.6**	6.2***	6.0***	0.81
M. longissimus [e]	3.7	3.7	4.6***	4.0	3.8	4.3***	4.1***	0.24
M. psoas major [f]	1.5	1.5	1.7***	1.6	1.5	1.6***	1.6***	0.07
M. semimembranosus [g]	4.1	4.1	4.7***	4.1	3.8	4.5***	4.5***	0.15
M. semitendinosus [h]	5.9	5.9	7.0***	6.2	5.8	6.6	6.3	0.22
M. quadriceps femoris [i]	3.9	3.7*	4.2***	4.0	3.7	4.1	3.9	0.13
M. gluteus medius [j]	1.8	1.8	2.1***	1.9	1.7	2.0***	2.0**	0.08

[a] SEM - standard error of mean (complete slaughter data: n = 186; commercial cutting: n = 6); [b] differences between the breed groups were compared using Dunnett's test so that purebred Hol was used as a control breed; *** ($P < 0.001$), **($P < 0.01$), * ($p < 0.05$); [c] conformation: (1 − poorest, 15 - excellent); [d] fat cover: (1 − leanest, 5 − fattest); [e] loin; [f] tender loin; [g] Inside round; [h] outside round; [i] corner round; [j] roast beef

(Tables 2 and 3). The average carcass weights of the NR × Ab, NR × Ba, NR × Ch, NR × Hf, NR × Li and NR × Si crossbreds were 12, 16, 20, 15, 15 and 17% higher, respectively, than that of pure NR heifers. Respectively, carcass weights of the Hol × Ab, Hol × Ba, Hol × Ch, Hol × Hf, Hol × Li and Hol × Si crossbreds were 6, 14, 18, 11, 14 and 13% higher compared to pure Hol heifers. The estimated daily carcass gain improved more (26–28%) with Ch crossbreds compared to pure dairy heifers. The rest of used crossbreds improved carcass gain 11–23% compared to pure dairy heifers (Tables 2 and 3).

The EUROP conformation score of the purebred NR heifers (3.4 on average) was 13% higher compared to the pure Hol heifers (3.0) ($P < 0.001$) but there was no difference in carcass fat score between purebred NR and Hol heifers. The conformation score of the NR heifers improved most (62–74%) by using Ba, Li and Ch sires ($P < 0.001$; Table 2). NR × Ab and NR × Hf crossbreds produced 35–38% and NR × Si crossbreds 44% better conformed carcasses compared to pure NR heifers ($P < 0.001$). With Hol heifers improvements in conformation were clearly greater than with NR breed (Table 3). The conformation score of the Hol heifers improved 83–90% by using Ba, Li and Ch sires and 50–57% by using Ab, Hf and Si sires ($P < 0.001$). The carcass fat score of the pure dairy heifers was 8% higher compared to the dairy × Ba heifers ($P < 0.001$; Tables 2 and 3). With NR × Ab, NR × Ch, NR × Hf, NR × Li and NR × Si crossbreds the carcass fat score was 33, 7, 41, 7 and 15% higher compared to pure NR heifers ($P < 0.001$). Respectively, with Hol × Ab, Hol × Ch, Hol × Hf, Hol × Li and Hol × Si crossbreds the carcass fat score was 22, 11, 37, 11 and 15% higher compared to pure Hol heifers ($P < 0.001$).

Dataset from commercial cuttings included 751 purebred NR and 486 Hol heifers but the amount of the crossbreds was limited (6–185 heifers per breed group; Tables 2 and 3). The carcass weights were consistent with those in the complete slaughter data. Breed group had clear effects on the yield (%) of cuttings. The yield of subcutaneous fat was significantly lower in the pure dairy heifers compared to the Ab and Hf crossbreds. On the other hand, the yield of subcutaneous fat was 32–37% higher with purebred dairy heifers compared to the Ba crossbreds ($P < 0.001$). There were no significant differences in the yield of subcutaneous fat when pure dairy heifers were compared to the Ch, Li or Si crossbreds (Tables 2 and 3).

The yields of loin, tenderloin, inside round, outside round, corner round and roast beef were significantly higher in Ba, Li and Si crossbreds (excluding the yield of corner round in NR × Si, Hol × Li and Hol × Si crossbreds) than in pure dairy heifers (Tables 2 and 3). Additionally, the yields of loin, outside round and roast beef were higher with NR × Ch crossbreds compared to pure NR heifers. Only few differences were observed in the yield of the high value joints (rounds, loins), when pure dairy heifers compared to Ab and Hf crossbreds. However, the yield of corner round was lower in Ab crossbreds than in pure dairy heifers. In addition, the yields of tender loin in NR × Ab crossbreds and inside round in NR × Hf crossbreds were lower compared to pure NR heifers (Table 2).

Average carcass weights in different EUROP fat score classes and the incidence of different fat scores in breed groups are presented in Table 4. The most common class for NR, NR × Ch, NR × Li and NR × Si heifers was fat score 3, including 45, 48, 47 and 49% of all observations within breed group, respectively. For NR × Ab and NR × Hf crossbreds fat score 4 incidence was greater than score 3, being 40 and 48%, respectively. For NR × Ba heifers the most common class was fat score 2, including 47% of all observations. Considering fat score 5, it is noticed that 15 and 19% of NR × Ab and NR × Hf carcasses were placed to this category, respectively. For other breed groups less than 6% of carcasses ranked to class 5. The results were quite similar with Hol crossbreds. The most common class for Hol, Hol × Ab, Hol × Ch, Hol × Li and Hol × Si heifers was fat score 3, including 43, 39, 47, 48 and 46% of all observations within breed group, respectively. For Hol × Ba heifers fat score 2 included 46% of all observations and fat score 3, respectively, 44%. For Hol × Hf crossbreds fat score 4 incidence was greater than score 3, being 43%. Considering fat score 5, 10 and 18% of Hol × Ab and Hol × Hf carcasses were placed to this category, respectively.

In general, the average carcass weights of the late maturing crossbreds in different fat score classes were higher compared to pure dairy heifers (Table 4). For example, in fat score 3 the average carcases NR × Ba, NR × Ch, NR × Li and NR × Si crossbreds, respectively, compared to pure NR heifers. Respectively, the average carcass weights of Hol × Ba, Hol × Ch, Hol × Li and Hol × Si crossbreds in fat score 3 were 16, 13, 9 and 7% higher compared to pure Hol heifers. There were only limited differences when the carcass weights of pure dairy heifers were compared to those of Ab and Hf crosses in different fat score classes (Table 4).

Table 4. Average carcass weights of purebred Nordic Red (NR), Holstein-Friesian (Hol) and dairy × beef breed crossbred heifers in different EUROP fat score classes (1 − leanest, 5 − fattest). (Ab − Aberdeen Angus, Ba − blonde d'Aquitaine, Ch − charolais, Hf − hereford, Li − limousin, Si − simmental)

	Breed group							SEM[a]
	NR×NR	NR×Ab	NR×Ba	NR×Ch	NR×Hf	NR×Li	NR×Si	
Total, n	14 218	1 626	1 136	802	486	3 699	827	
Fat score	n (observations/fat score)							
1	814	24	59	14	2	70	8	
2	4 763	128	530	237	31	1 023	163	
3	6 378	591	440	384	126	1 747	404	
4	2 017	645	103	143	233	741	207	
5	246	238	4	24	94	118	45	
Fat score	Carcass weight (kg) in different fat score classes							
1	115	94°	150***	175***	111	135***	153*	27.9
2	184	178	221***	219***	178	210***	206***	5.6
3	214	211°	251***	247***	220°	237***	235***	2.3
4	236	238	272***	268***	235	259***	258***	2.5
5	259	267**	304**	289***	261	282***	286***	13.4

	Breed group							SEM[a]
	Hol×Hol	Hol×Ab	Hol×Ba	Hol×Ch	Hol×Hf	Hol×Li	Hol×Si	
Total, n	6 347	531	467	438	186	1 249	393	
Fat score	n (observations/fat score)							
1	436	17	26	9	1	32	10	
2	2 107	73	214	121	15	320	79	
3	2 731	207	204	204	57	594	179	
4	971	181	21	89	80	265	102	
5	102	53	2	15	33	38	23	
Fat score	Carcass weight (kg) in different fat score classes							
1	131	110	173***	168*	62	157**	129	38.0
2	190	184	225***	219***	183	214***	201**	7.1
3	219	214*	255***	248***	214	238***	235***	3.2
4	243	241	275***	276***	237	264***	258***	5.3
5	268	270	285	300***	271	279	290**	20.7

[a] SEM - standard error of mean; [b] differences between the breed groups were compared using Dunnett's test so that purebred dairy breed was used as a control breed; *** (P < 0.001), ** (P < 0.01), * (p < 0.05), °(p < 0.10)

Discussion

Compared to the recent Finnish experimental data sets for dairy heifers with typical Finnish grass silage-based diets (Huuskonen et al., 2009), the average lifetime carcass gain was approximately 7% lower in the present field data (415 g · d^{-1}) than in the feeding trial (445 g · d^{-1}, average for three feeding treatments). This difference probably illustrates variable feeding regimes and management factors at farm level compared to the controlled experimental environments. Typically all calves transferred from dairy farms are housed and fed consistently in finishing farms, i.e. different methods are not used for pure dairy breeds and dairy × beef crossbred heifers within a finishing farm. Therefore it can be assumed that the results of the present data represent well the differences between the breed groups in Finnish cattle population.

The higher growth capacity of the dairy × late maturing beef breed crosses compared to the pure dairy breeds has been demonstrated in numerous studies (e.g., Roux et al., 1987; More O'Ferrall and Keane, 1990). For example, Roux et al. (1987) observed that the crossbred Friesian × Charolais heifers showed improved growth, resulting in heavier and leaner carcasses at the same age compared to purebred Friesian heifers. However, it can be inferred from data compiled by Kempster and Southgate (1984) and Keane et al. (1989) that there was little difference in growth rate between Friesians and Limousin crosses in some trials. Also Andersen et al. (1977) found that Limousin cross young bulls from dairy cows had lower daily liveweight gains than and similar daily carcass gains as Danish Red and White young bulls. Southgate et al. (1988) reported similar live growth rates for

Friesian, Friesian × Hf and Friesian × Li steers in a 16-month beef system but in a 24-month system the Limousin crosses were superior.

The fact that there are differences between breed types in conformation and fat scores has been well established previously in experimental data sets (More O'Ferrall and Keane, 1990; Keane and Allen, 2002), and this was also the case in the present large field data. For example, the superiority of the Hol × Li and Hol × Ba crossbred heifers for carcass conformation compared to pure dairy heifers corresponded to the results reported by Keane et al. (1989) with Friesian, Friesian × Limousin and Friesian × Blonde d'Aquitaine steers. Furthermore, Keane and More O'Ferrall (1992) observed that Friesian × Hereford and Friesian × Simmental steers conformed 36 and 40% better than purebred Friesians, respectively. The differences in conformation score suggested a superior muscling of the dairy × Ab and dairy × Hf crosses compared to pure dairy heifers. However, in terms of valuable cuts there were only limited differences between dairy, dairy × Ab and dairy × Hf heifers. Studies summarized by Craigie et al. (2012) indicated that the percentage of variation in carcass lean meat yield explained by the EUROP grid was much greater using the entire carcass (R^2 range 0.55–0.75) than using high-value cuts only (R^2 range 0.28–0.57). However, while these high-value cuts are a small percentage of the carcass lean meat yield, they account for a large proportion of carcass value. Therefore, Craigie et al. (2012) concluded that there is a clear need for an accurate commercial measurement or prediction methods for true value of the carcasses which is supported also by the present data.

Dairy × late maturing breed heifers had higher proportions of many high value joints (rounds, loins) compared to purebred dairy heifers. Other studies have also shown that the late maturing breed type cattle have higher proportions of high value joints than early maturing breed crosses or pure dairy breeds (Keane et al., 1989, 1990; Keane and More O'Ferrall, 1992). The higher lean and lower fat contents in the carcasses of the Friesian × Li than in Friesian cattle have reported Kempster et al. (1988), Keane et al. (1989) and Steen and Kilpatrick (1995). Furthermore, Forrest (1981) observed that the crossbred Holstein × Li steers had more lean and less fat than the purebred Holstein-Friesian steers, and similar results were reported also by Kempster et al. (1976) for fat and Kempster and Jones (1971) for lean when comparing purebred Friesian and Friesian × Limousin crossbreds.

Higher slaughter weights of crossbreds probably explained the increased fat score compared to pure dairy heifers, because measures of fatness generally increase with higher carcass weight (Keane and Allen, 1998). However, the carcass fat score of the dairy × Ba heifers was lower than that of the pure dairy heifers at a constant age in the present study. Similarly, Schenkel et al. (2004) reported with purebred beef bulls that Blonde d'Aquitaine bulls showed the least back fat thickness, followed by Limousin, Charolais and Simmental when breed differences for growth and body composition traits were studied in Ontario bull test stations from 1991 to 2000. In that case, the Hf bulls had the highest level and the Ab bulls the second highest level of backfat thickness (Schenkel et al., 2004). Also Bartoň et al. (2006) concluded that, in general, the animals of earlier maturing breeds (Hf, Ab) produced relatively more fat than later maturing (Ch, Si) in spite of the fact that they were slaughtered at a significantly lower liveweight. This statement is supported by the present data with crossbred heifers.

If beef output is to be maintained in Finnish beef industry, carcass weights must increase. However, increasing carcass weight with the present breed distribution is not desirable, as beef carcasses are already adequately fat or over-fat at existing carcass weights (Herva et al., 2011). The way by which carcass weight can increase without a subsequent increase in fatness is through a change in breed distribution. According to the present data the NR, Hol, dairy × Ab, and dairy × Hf heifers would obtain carcass fat class 3 at carcass weights of about 210–220 kg but dairy × late maturing crossbreds at carcass weights of about 235–255 kg. Thus the use of late maturing rather than early maturing bulls on dairy cows would permit carcass weight of the progeny to increase 10–20% without an increase in carcass fatness. Alternatively, in recognition of the growing consumer demand for beef with less fat, the fat content of dairy × late maturing carcasses would be lower than that of purebred dairy or dairy × early maturing carcasses of similar weight.

Conclusions

The large dataset collected in this study describes well growth and carcass traits of slaughtered heifers in Finnish dairy population. Our results revealed that improvements in beef production traits obtained by crossbreeding dairy cows with beef breed sires are highly dependent of the choice of sire breed. Crossbreeding dairy cows with late maturing beef breeds (Blonde d' Aquitaine, Charolais, Limousin, Simmental) had favourable effects both on daily carcass gain and carcass quality traits (conformation, proportion of high value joints) of the progeny when compared to purebred dairy heifers. The effects of crossbreeding dairy cows with Aberdeen Angus or Hereford sires were variable. No advantages in proportion of high value joints seemed to be obtained by crossbreeding with these early maturing breeds, while the improvements in daily carcass gain and carcass conformation score were intermediate compared to the late maturing crossbreds. It can be concluded that crossbreeding, especially with late maturing bulls, largely improve carcass production compared to purebred dairy cattle.

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