MARTIN-LUTHER-UNIVERSITY HALLE-WITTENBERG
Institute of Agricultural and Nutritional Sciences, Group Animal Breeding

60th Annual Meeting of the European Federation of Animal Science
Barcelona, Spain August 24-27, 2009. Session 4, Paper 9

Brown Swiss x Holstein crossbreds compared to pure Holsteins for production in first two lactations

S. Blöttner, M. Wensch-Dorendorf, H. H. Swalve*

*presenting

Aim of the study

- Assess competitiveness of F_1-crossbreds under the conditions of a high yielding herd (~ 11.000 kg herd average)
- Use random regression model for analysis of daily yields

Experimental design

Crossbreeding initiated in the fall of 2002 at the experimental station “Iden“, Germany

2002 to 2003

- 10 Brown Swiss AI sires and 10 Holstein AI sires
- 15 matings per bull

2004 to 2008

- Pure Holsteins bred to Holstein AI sires
- Brown Swiss x Holstein crossbreds bred to Fleckvieh AI sires

Experimental units

	Holstein	BS x Holstein
Live heifer calves	56	66
Calve losses	- 2	- 9
Heifers bred	54	57
First calvers	50	55

Experimental units, continued

	Holstein	BS x Holstein
First-calf heifers	50	55
Second calvers	43 (86%)	46 (84%)
Third calvers	33 (66%)	35 (64%)

RIVERLAND -daughter
2. Parity 305 day: 11672kg milk;
3,75 % fat; 3,35 % protein
1. Parity 305 day: 10144kg milk;
3,67 % fat; 3,36 % protein

HOLSTEIN

BS x HOL

GORDON -daughter
2. Parity 305 day:12999 kg milk
4,02 % fat ; 3,48 % protein
1. Parity 305 day:10390 kg milk;
3,74 % fat ; 3,48 % protein

Analysis for production

- 1st and 2nd lactations analyzed with PROC MIXED
- Random regression test day model was used
- Dependent variable milk (kg),

  fat (kg, %)

  protein (kg,%) production and

  SCS

Analysis for production, continued

$$y_{rkji} = \sum_{m=1}^{3} \beta_{rm} f_{rm} + \sum_{m=1}^{3} b_{km} a_{km} + agef_j + td_i + e_{rkji}$$

y_{rkji} = dependent variable (milk, fat, protein, SCS) within lactation

β_{rm} = is the m-th term of Wilmink function of the fixed regression function r = crossbred or purebred with β_{r1} =1, β_{r2} = d and β_{r3} =$e^{-0.05\,d}$ and d denoting days in milk (DIM)

f_{rm} = the m-th regression coefficient of the r-th fixed regression curve

b_{km} = is the m-th term of the third-order Legendre polynomials with b_1 =1, b_2 = $\sqrt{3}z$ and b_3 = ½ $\sqrt{5}(3z^2 -1)$ and z = (d - 5)/150 -1

a_{km} = m-th random regression coefficient for effects of cow k

$agef_j$= age at first calving; td_i = test day; e_{rkjin} = error effect.

LS Means and s.e. in 1st lactation for daily production

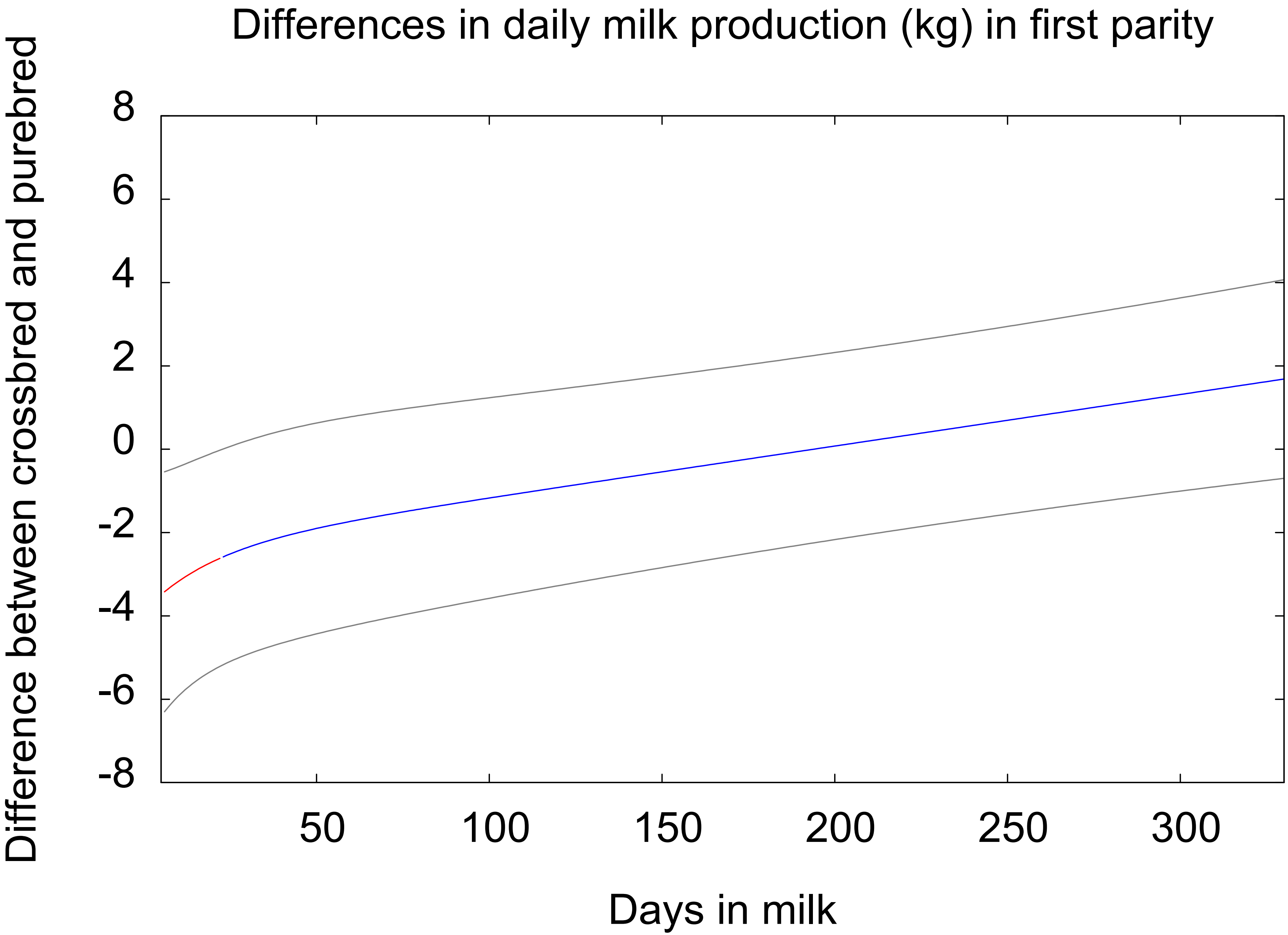
Trait	Holstein	BS x Holstein	Difference
Cows	50	55	
Milk (kg)	28.77 (0.83)	28.28 (0.79)	-.49
Fat (kg)	1.18 (0.03)	1.19 (0.03)	+.01
Protein (kg)	0.98 (0.03)	1.00 (0.03)	+.02
Fat (%)	4.09 (0.06)	4.25 * (0.05)	+.16
Protein (%)	3.57 (0.03)	3.71**(0.03)	+.14
SCS	2.02 (0.13)	1.71 † (0.12)	+.31

** $p < 0.01$, * $p < 0.05$, † $p < 0.10$, n = 4132 test day records

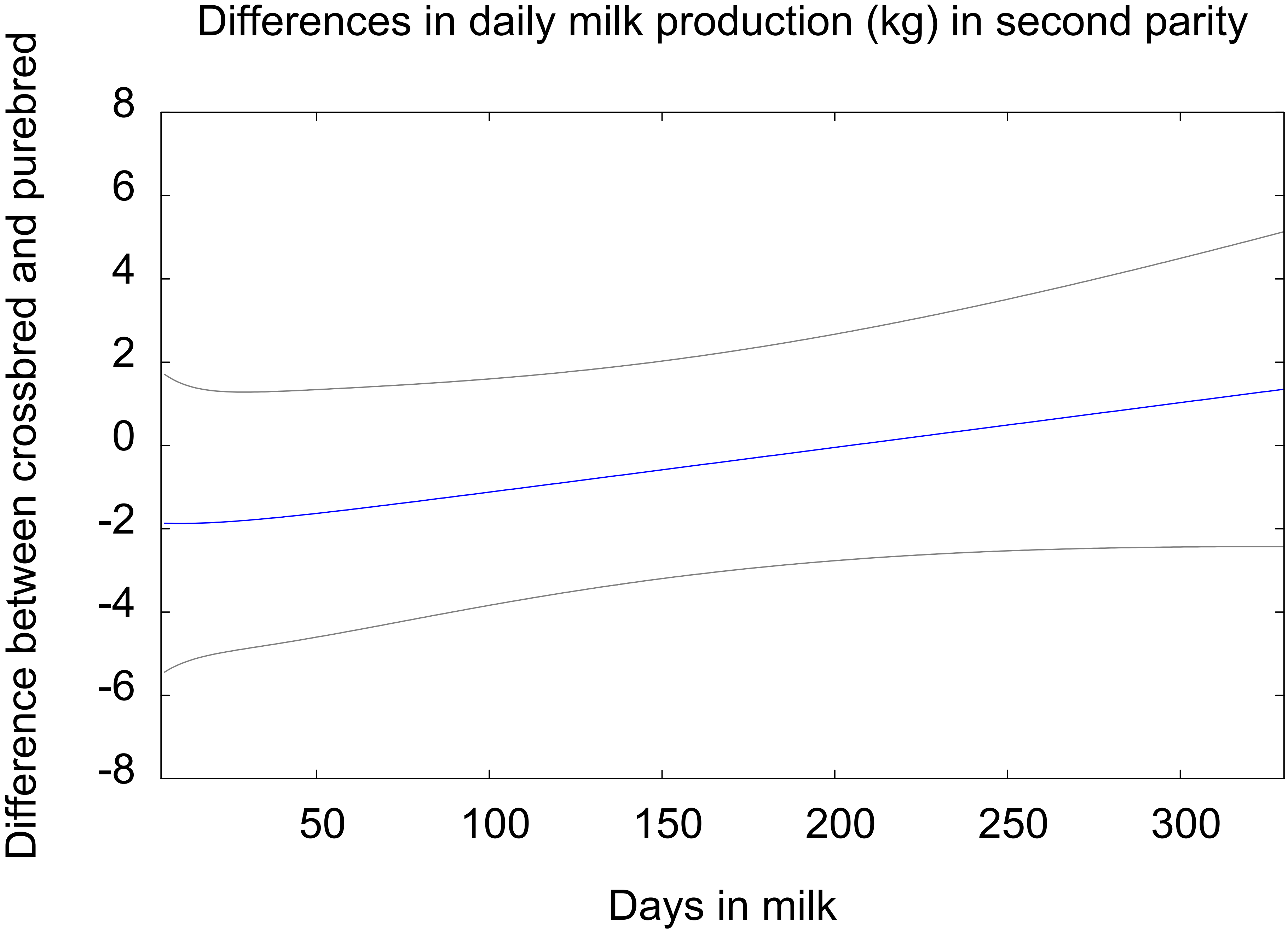
LS Means and s.e. in 2nd lactation for daily production

Trait	Holstein	BS x Holstein	Difference
Cows	43	46	
Milk (kg)	34.40 (0.96)	33.93 (0.91)	-.47
Fat (kg)	1.40 (0.03)	1.43 (0.03)	+.03
Protein (kg)	1.21 (0.03)	1.22 (0.03)	+.01
Fat (%)	4.15 (0.07)	4.33† (0.06)	+.18
Protein (%)	3.58 (0.03)	3.70**(0.03)	+.12
SCS	2.57 (0.15)	2.32 (0.15)	+.25

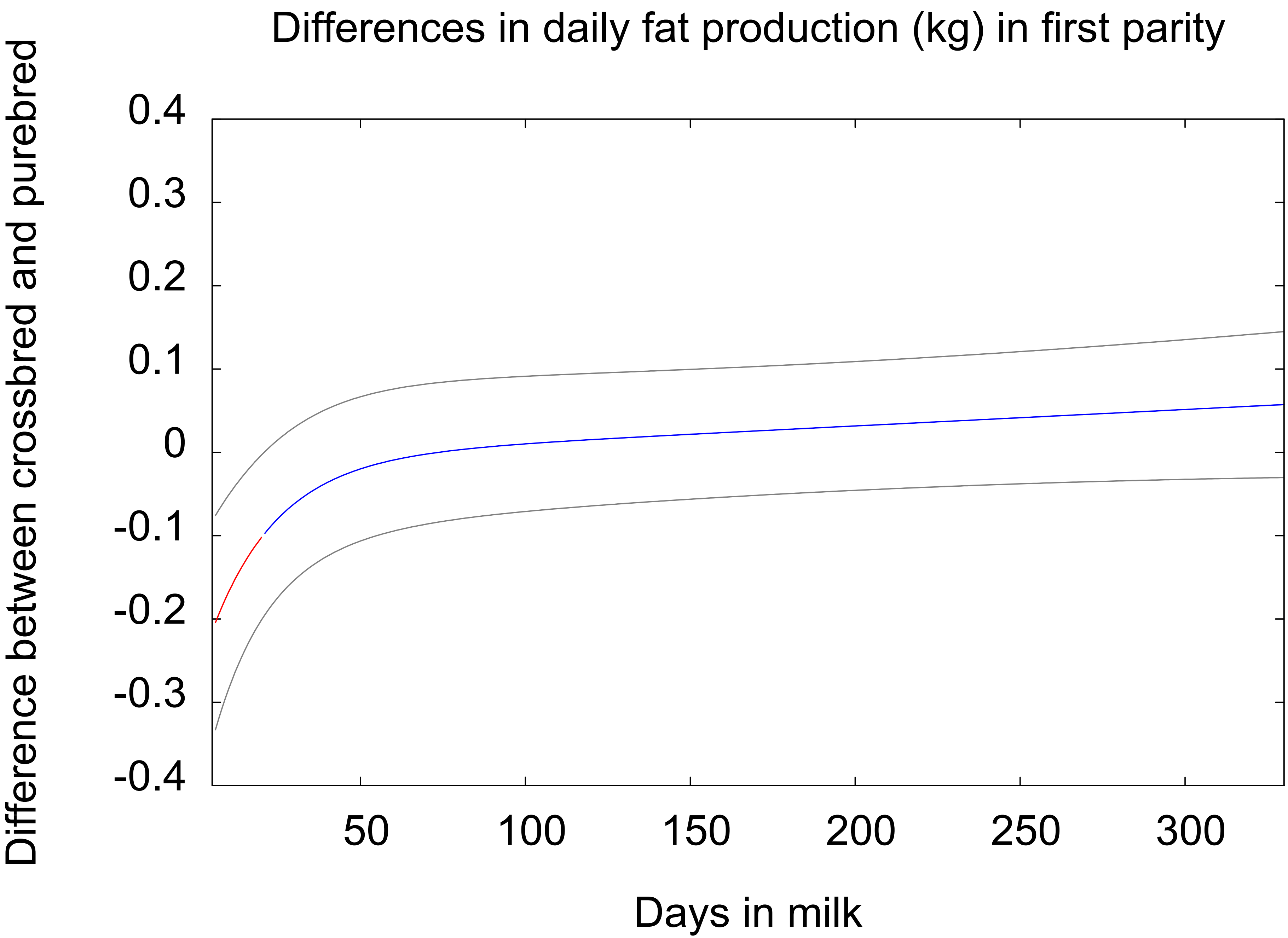
** $p < 0.01$, † $p < 0.10$, n = 3502 test day records



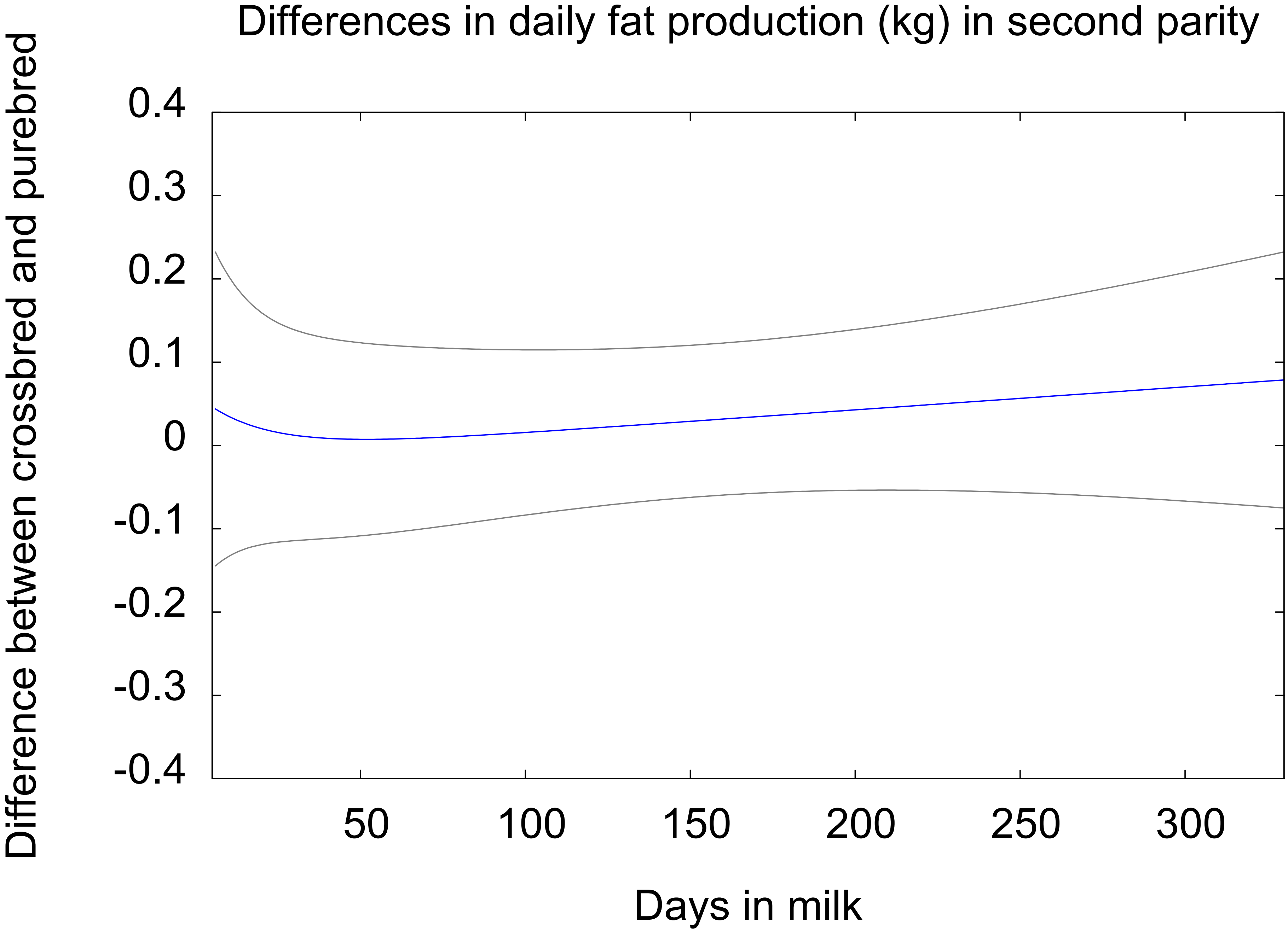
Differences in daily milk production (kg) in first parity
Difference between crossbred and purebred
8
6
4
2
0
-2
-4
-6
-8
50
100
150
200
250
300
Days in milk

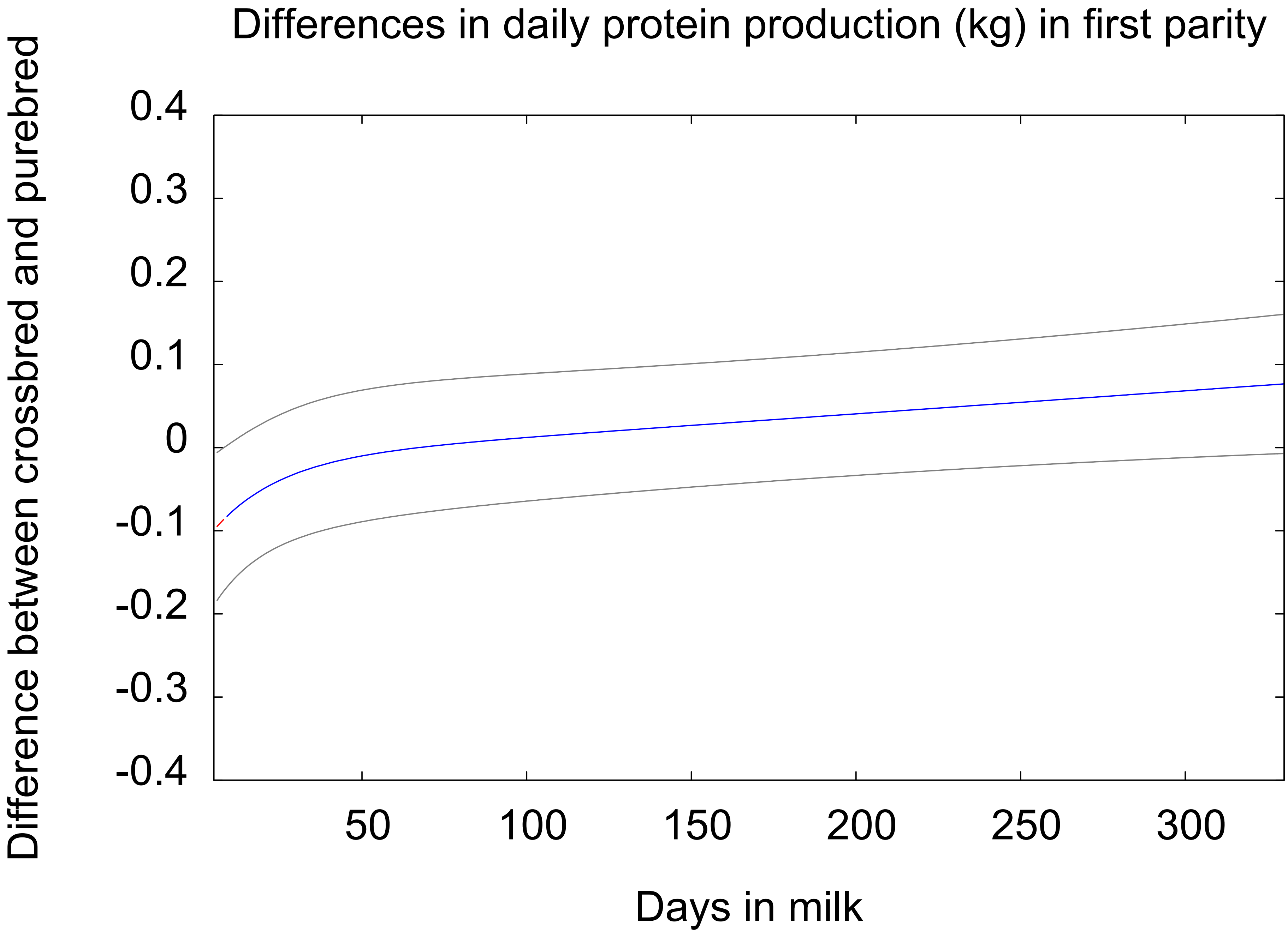


Differences in daily milk production (kg) in second parity
Difference between crossbred and purebred
8
6
4
2
0
-2
-4
-6
-8
50
100
150
200
250
300
Days in milk

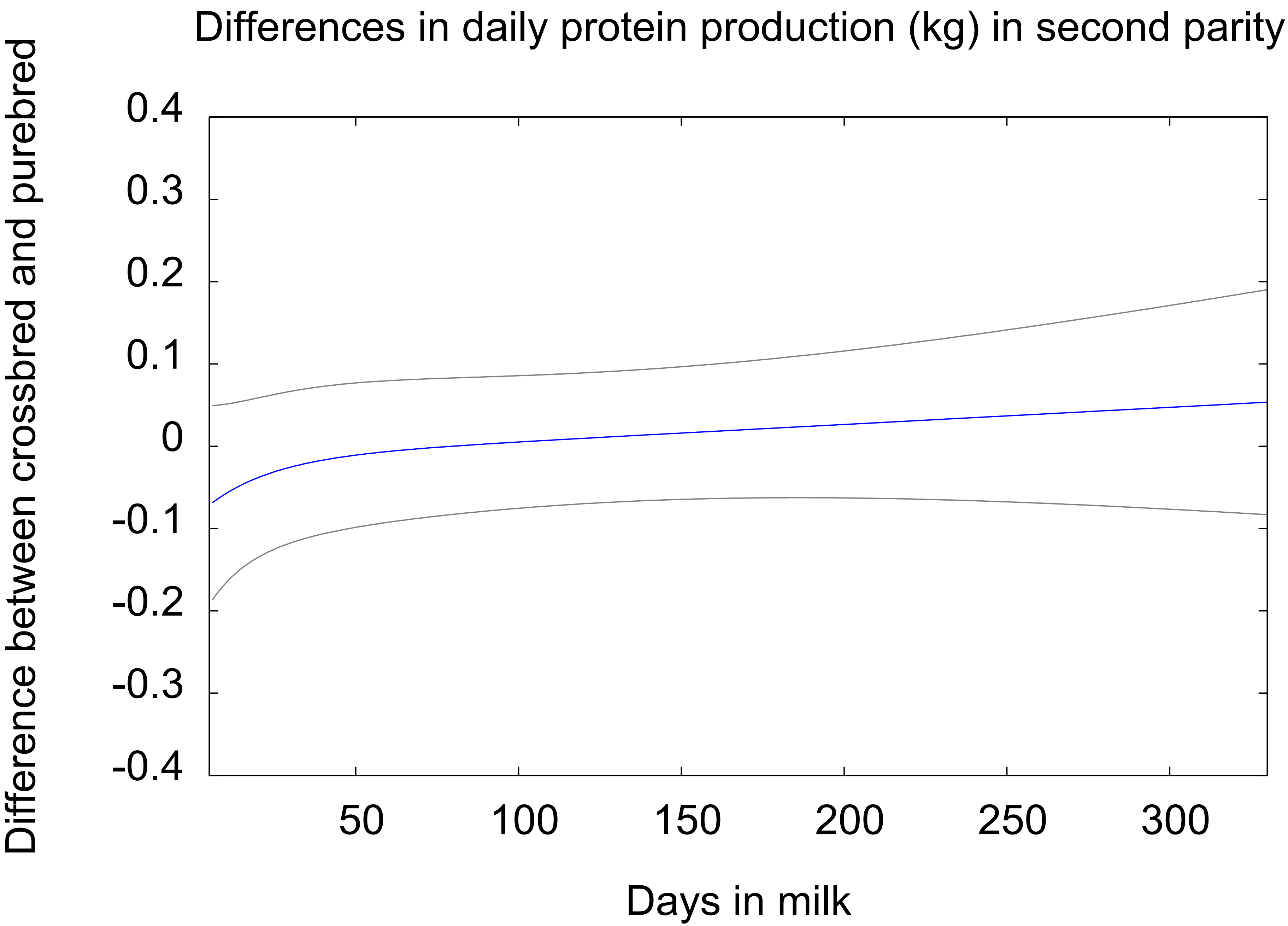


Differences in daily fat production (kg) in first parity
Difference between crossbred and purebred
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
50
100
150
200
250
300
Days in milk

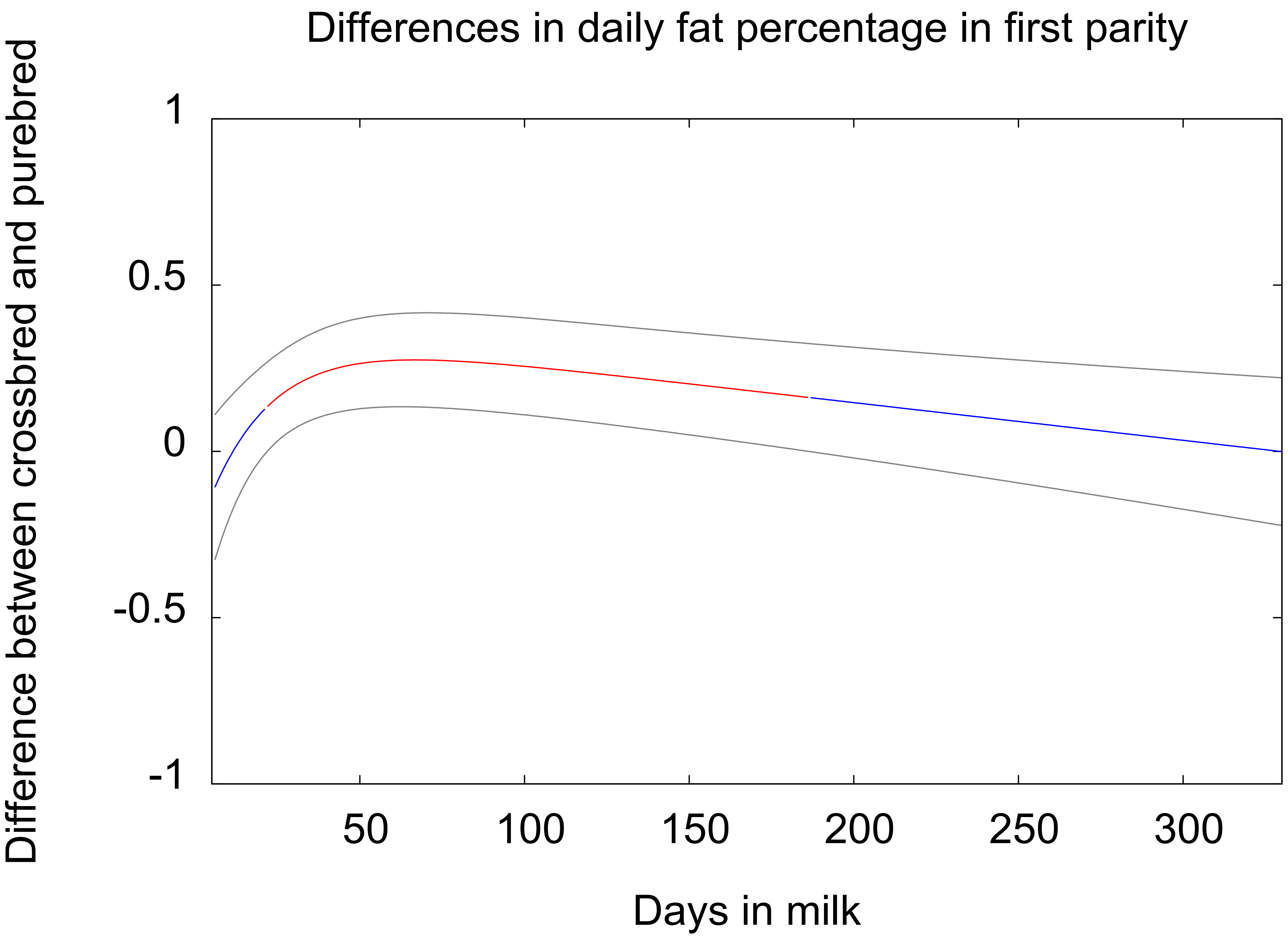

Differences in daily fat production (kg) in second parity
Difference between crossbred and purebred
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
50
100
150
200
250
300
Days in milk

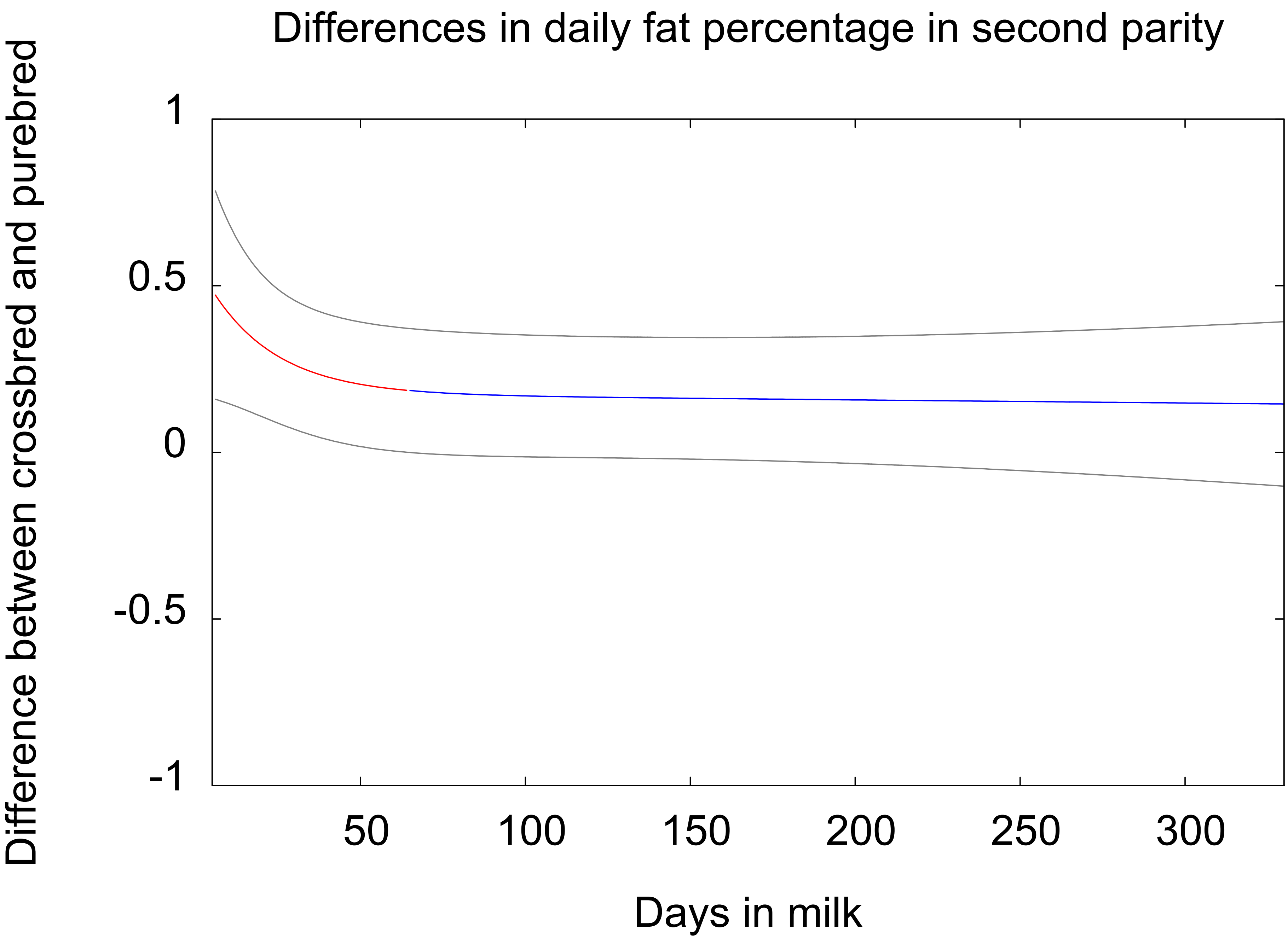


Differences in daily protein production (kg) in first parity
Difference between crossbred and purebred
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
50
100
150
200
250
300
Days in milk

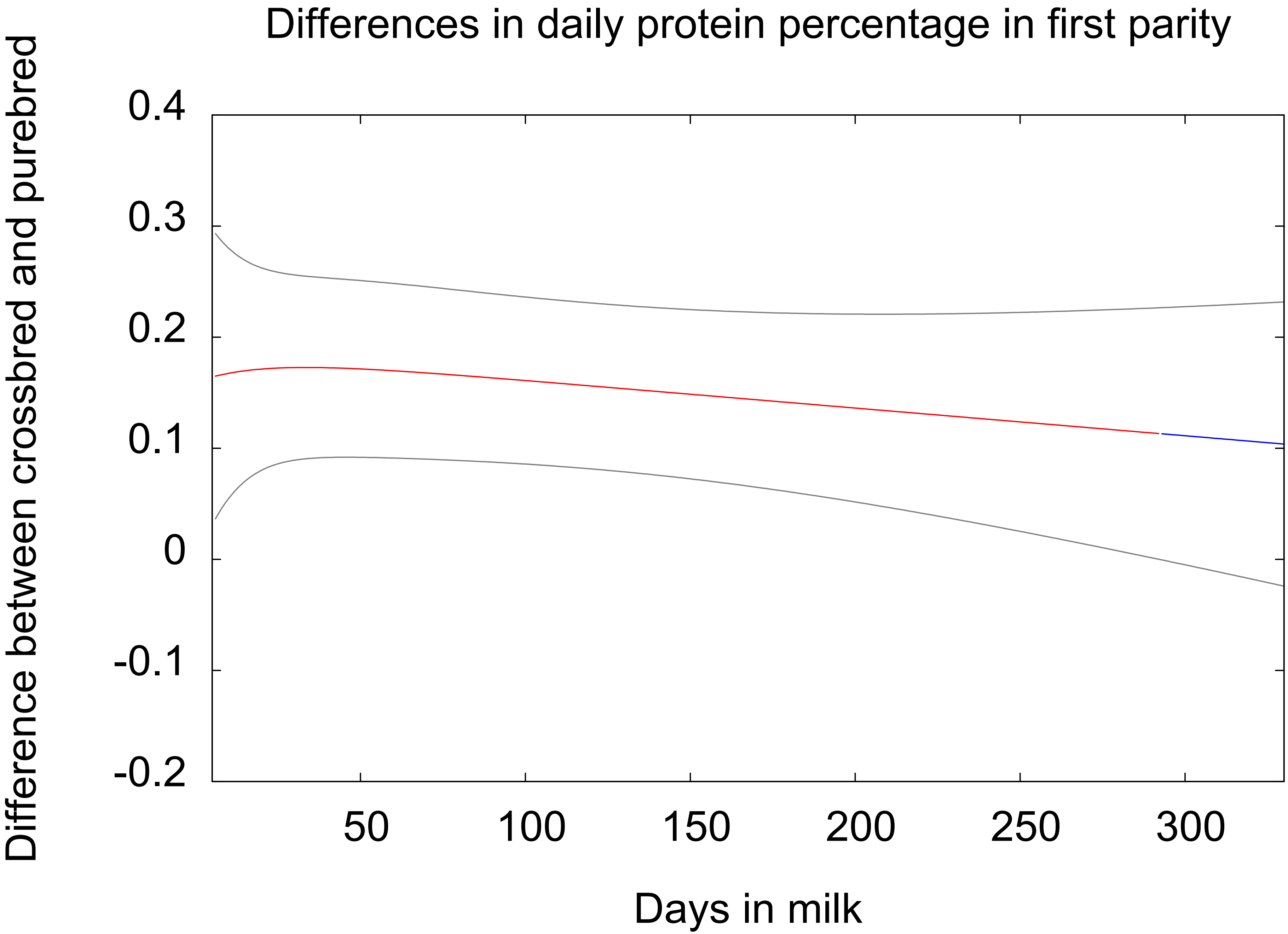


Differences in daily protein production (kg) in second parity
Difference between crossbred and purebred
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
50
100
150
200
250
300
Days in milk

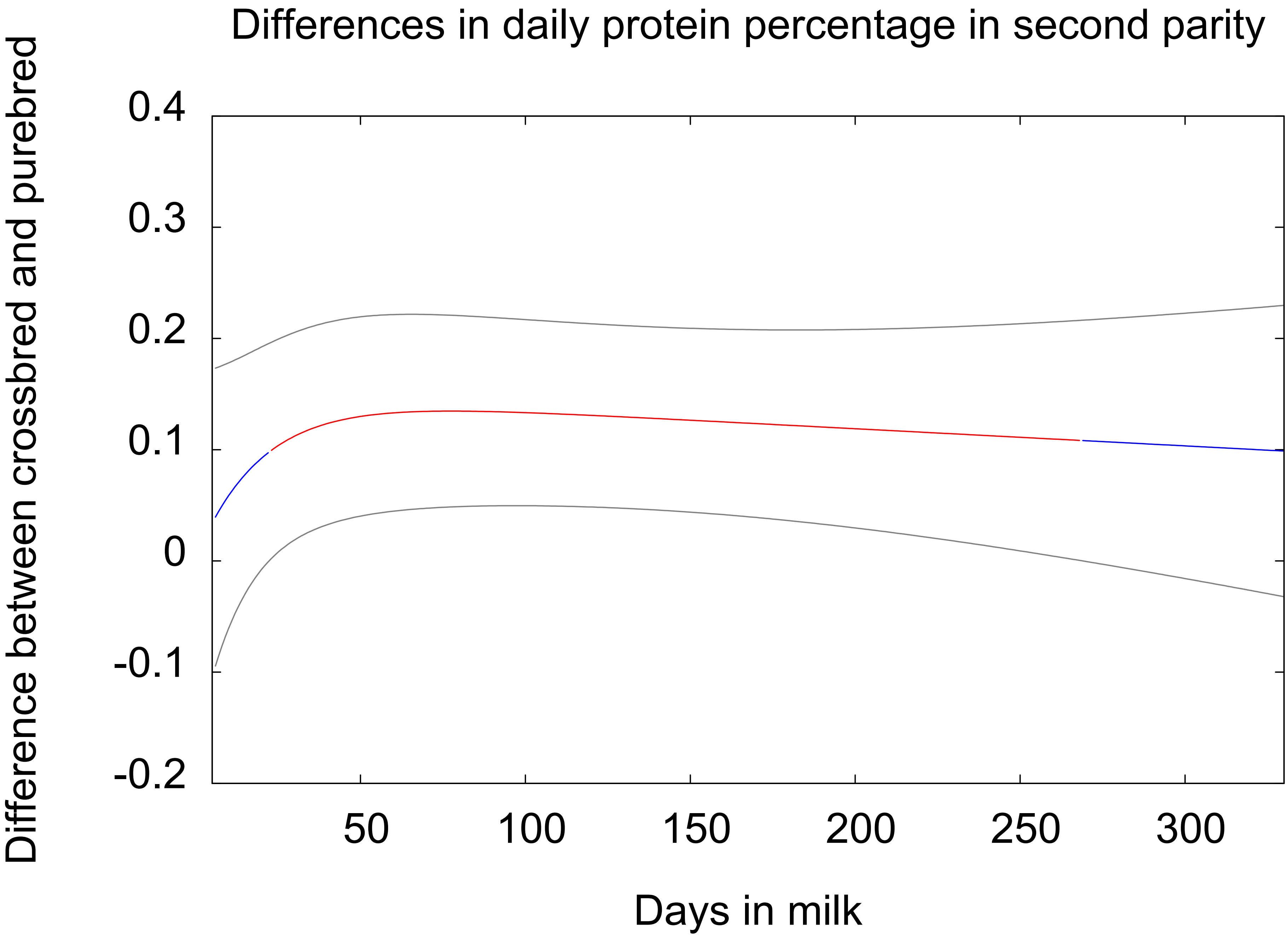

Differences in daily fat percentage in first parity
Difference between crossbred and purebred
1
0.5
0
-0.5
-1
50
100
150
200
250
300
Days in milk

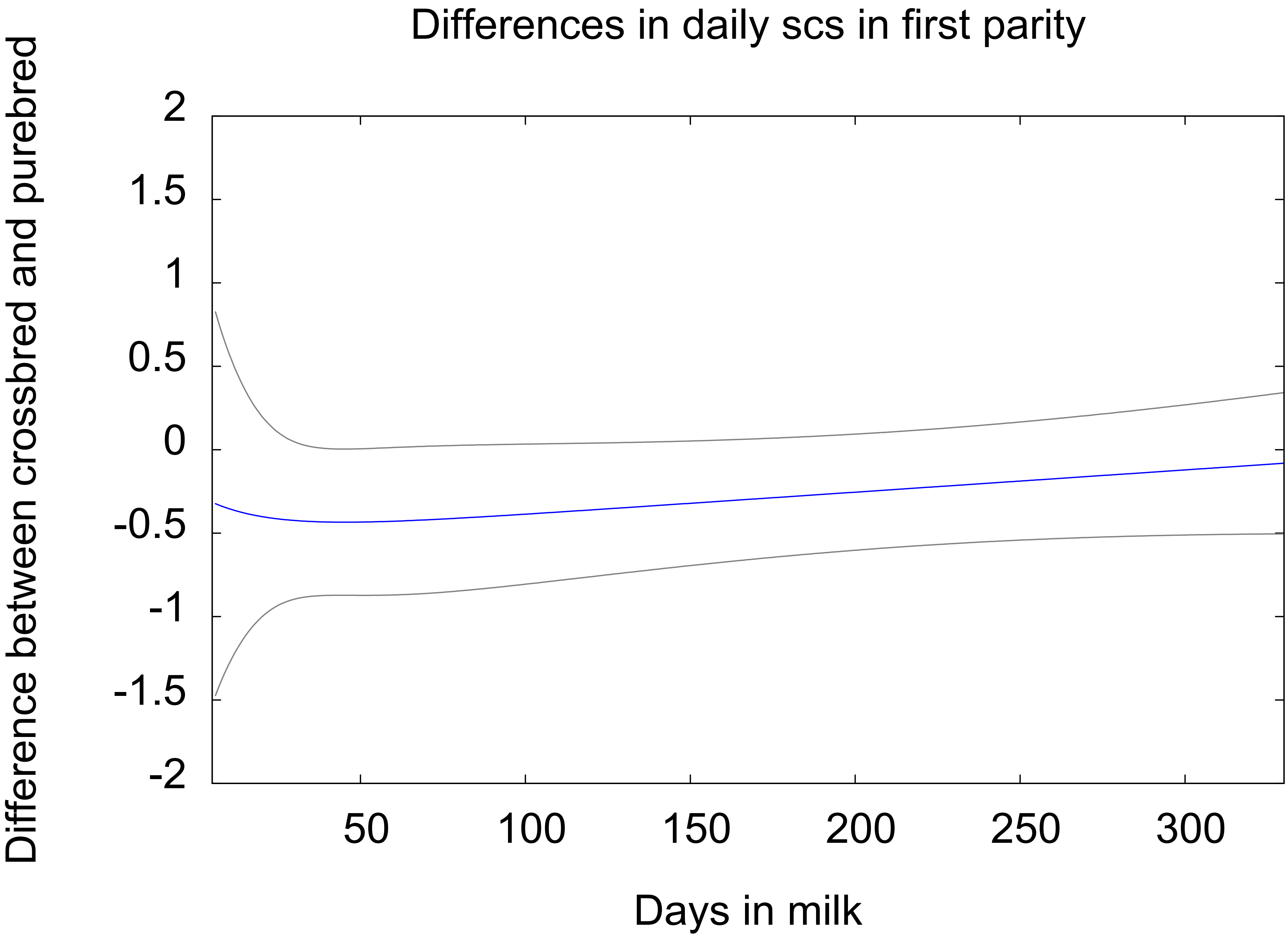


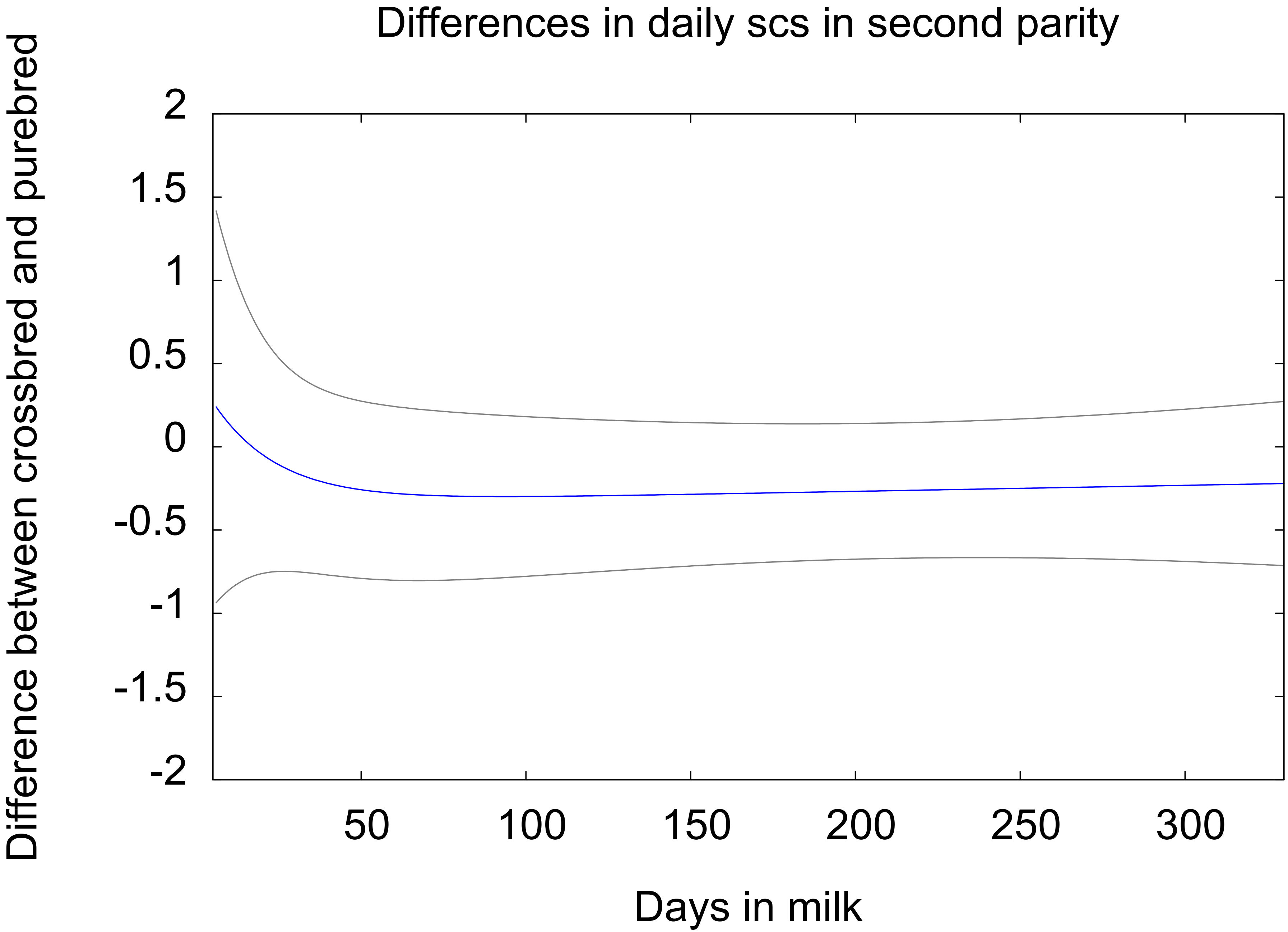
Differences in daily fat percentage in second parity
Difference between crossbred and purebred
1
0.5
0
-0.5
-1
50
100
150
200
250
300
Days in milk



Differences in daily protein percentage in first parity
Difference between crossbred and purebred
0.4
0.3
0.2
0.1
0
-0.1
-0.2
50
100
150
200
250
300
Days in milk


Differences in daily protein percentage in second parity
Difference between crossbred and purebred
0.4
0.3
0.2
0.1
0
-0.1
-0.2
50
100
150
200
250
300
Days in milk


Differences in daily scs in first parity
Difference between crossbred and purebred
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
50
100
150
200
250
300
Days in milk



Differences in daily scs in second parity
Difference between crossbred and purebred
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
50
100
150
200
250
300
Days in milk

Conclusions

- Brown Swiss x Holstein crossbreds and pure Holsteins did not differ for milk, fat and protein production during the first two paritys
- Brown Swiss x Holstein crossbreds and pure Holsteins were significantly different for fat % and protein % during the first two parities
- Brown Swiss x Holstein crossbreds tend to have a lower SCS than pure Holsteins in first parity
- (Not shown) Brown Swiss x Holstein crossbreds showed an improved fertility compared to pure Holsteins

Acknowledgements

- Bernd Fischer and co-workers of the experimental

Station “Iden” for

their assistance in

data collection and

care of the animals

Brown Swiss x Holstein crossbreds compared to pure Holsteins for production in first two lactations.

S. Blöttner*, M. Wensch-Dorendorf and H. H. Swalve

Institute of Agricultural and Nutritional Sciences, Group Animal Breeding
Martin – Luther – University Halle – Wittenberg, Germany
Theodor – Lieser – Str. 11, D-06120 Halle / Saale Germany
stefan.bloettner@landw.uni-halle.de*,
monika.dorendorf@landw.uni-halle.de,
hermann.swalve@landw.uni-halle.de
*corresponding author

ABSTRACT

Brown Swiss x Holstein crossbreds (**BSH**, n = 55) were compared to pure Holsteins (**HOL**, n = 50) during the first two lactations for milk, fat, protein production and SCS at the experimental station in Iden, Germany. Cows calved from September 2005 to November 2007 and were housed in the same environment under the same management conditions. All animals originated from a designed experiment. The data used was based on weekly test days. The model used was analogous to the model used in national evaluations in Germany. Fixed regressions were based on the Wilmink function. Fixed regression coefficients were estimated within breed group. Random regressions were third order Legendre polynomials. The fixed effects of breed group, age of first calving, and test day were included. All parameters were estimated with SAS (Proc Mixed). In addition, three intervals for days in milk (**DIM**) I1 = 5 – 100 DIM, I2 = 101 – 200 DIM and I3 = 201 – 300 DIM were defined. No significant differences ($P < 0.05$) were found for breed group effects for production in first and second lactation. BSH (1.70) tended ($P < 0.10$) to have lower SCS than HOL (2.02) in first lactation. The first 21 days in milk in I1 in first lactation showed significant differences ($P< 0.05$) in milk yield. No significant differences ($P > 0.05$) between BSH and HOL were found in I1 (-2.00 kg), I2 (-0.54 kg) and I3 (0.70 kg). Differences between BSH and HOL tended to be smaller from first to second lactation. BSH had more capacity in production at the end of each lactation. However, BSH had lower milk production level in early (I1) and mid (I2) lactation.

Keyword: Crossbreeding, random regression test day model

INTRODUCTION

The Holstein breed is the dominating dairy cattle breed in most countries. However, recently more and more questions have been raised whether instead of purebred Holsteins, crossbred cattle could be used for dairy production since crossbreds should exhibit hybrid vigour especially for functional traits, e.g. longevity and fertility (Heins et al., 2008). Quite clearly, crossbreds should only be used if additional benefits can be exploited given that crossbreds would be competitive for production traits. This requirement can only be met when other specialized dairy breeds are used as crossbreeding partners for the Holstein breed.
Aim of the present study was a comparison of purebred Holsteins with F_1 - Brown Swiss x Holstein crosses under intensive conditions in a high yielding dairy herd. The data used originated from a planned experiment conducted on an experimental farm. In the present study, differences in the lactation curve were estimated using a random regression test day model.

EXPERIMENTAL DESIGN

The crossbreeding experiment was initiated in 2002 at the experimental station 'Iden' Saxony-Anhalt, Germany. The dairy facility has a high yielding dairy herd with a herd average > 11.000 kg (uncorrected raw mean). Ten Holstein sires and 10 Brown Swiss sires were selected based on their estimated breeding values from the German national genetic evaluation and /or their Interbull proof. Consideration was given to the total merit index, as well as to the production index and the indices for longevity and conformation.

All animals originated from a designed experiment. Dams in the trial were all Holstein in an age of a first calving heifer up to a cow in the 5th lactation and assigned evenly distributed to purebred and crossbred matings. Fifty-six female Holstein (**HOL**) and 66 Brown Swiss x Holstein crossbreds (**BSH**) calves were born. During the rearing phase, 2 HOL and 9 BSH were lost for health reasons. Finally, 54 HOL heifers and 57 BSH heifers made it to their first breeding. Three HOL and 2 BSH heifers were culled for fertility reasons. Heifers calved into first lactation were 51 HOL and 55 BSH. One HOL was not included because of a broken hip. All calvings initiating the first and the second lactation, respectively, occurred from September 2005 to November 2007. All Animals were housed in the same environment and managed equal.

MATERIALS AND METHODES

Production data was recorded weekly. The test day recordings included milk (kg), fat (kg), protein (kg), fat (%), and protein (%). SCS was recorded in a four weekly interval. Finally, in first lactation 105 first calving heifers (50 HOL, 55 BSH) had 4132 test day records. In second lactation 89 (43 HOL, 46 BSH) cows had 3502 test day records. Test day records greater 330 days in milk (**dim**) were not included in the analysis. The analysis was done separately for each lactation to obtain differences between the breed groups for daily production. The model used was similar to the national German evaluation model but differed from the official model as relationships between animals were not accounted for and hence the cow effect included genetic as well as permanent environmental effects. A random regression test day model with fixed regressions component based on Wilmink function was used (1). The random regressions were third order Legendre Polynomials.

$$y_{rkji} = \sum_{m=1}^{3} \beta_{rm} f_{rm} + \sum_{m=1}^{3} b_{km} a_{km} + agef_j + td_i + e_{rkji} \qquad (1)$$

y_{rkji} = dependent variable (milk, fat, protein, SCS) within lactation
β_{rm} = is the m-th term of Wilmink function of the fixed regression function r = crossbred or purebred with β_{r1} =1, β_{r2} = d and β_{r3} =$e^{-0.05\,d}$ and d denoting days in milk (DIM)
f_{rm} = the m-th regression coefficient of the r-th fixed regression curve
b_{km} = is the m-th term of the third-order Legendre polynomials with b_1 =1, b_2 = $\sqrt{3}z$ and b_3 = ½ $\sqrt{5}(3z^2 -1)$ and z = (d - 5)/150 -1
a_{km} = m-th random regression coefficient for effects of cow k
$agef_j$ = age at first calving; td_i = test day; e_{rkjin} = error effect.

The coefficients were estimated simultaneously for each breed group using the method described by Mielenz et al. (2006). The fixed regression coefficients were used to estimate differences between the breed groups and test for significant differences. An exponential serial correlation was used to model the correlation between repeated measurements. The entire analysis was done using PROC MIXED of SAS (SAS Institute, 2004). In addition to the comparison of lactation curves, comparisons were made for the averages of the entire lactation and for time periods defined as I1 = 5 – 100 dim, I2 = 101 – 200 dim, and I3 = 201 – 300 dim.

RESULTS

Least square means and standard errors of means for production traits in first lactation are shown in Table 1 and for second lactation in Table 2. BSH (28.28 kg) were not significant different for milk production from HOL (28.77 kg) in first lactation. The least square means for fat yield, 1.19 kg vs. 1.18 kg, and protein yield, 1.00 kg vs. 0.98 kg, did not differ significantly between BSH and HOL. Significant differences ($P < 0.01$) were found in protein percentage between BSH (3.71 %) and HOL (3.57 %). Fat percent was significantly ($P < 0.05$) different between BSH (4.25 %) and HOL (4.09 %) in first lactation. A tendency ($P < 0.10$) was found for a lower SCS of BSH (1.71) vs. HOL (2.02).

In second lactation no significant differences were found for milk production. Both groups increased their milk production level. Also the level of fat and protein production increased for BSH (1.43 kg, 1.22 kg, respectively) and pure HOL (1.40 kg, 1.21 kg, respectively). Analogous to the results for first lactations, significant differences ($P < 0.01$) were found between BSH (3.70 %) and HOL (3.58 %) for protein (%) in second lactation. A tendency ($P < 0.10$) was found for fat (%) between the groups in second lactation (BSH: 4.33 % vs. HOL: 4.15 %). SCS increased in second lactation. BSH had lower SCS than pure HOL (2.32 vs. 2.57).

In the first lactation, only the first 21 days exhibited significant differences for milk (kg) production between the breed groups with higher yields for HOL. Significant differences for milk (kg) in second lactation were not found (Figure 1). However, within the sub-periods BSH had less milk production in I1 and I2 in both lactations and higher production in I3 in both lactations (Differences were -2, -.54, .70 and -1.57, -.58, .50, for I1, I2 and I3 in first and second lactation for the contrast BSH – HOL). No statistical differences ($P > 0.05$) were found within sub-periods for fat (kg) and protein (kg) production between the groups. However, significant differences were found for fat percentage and protein percentage in first and second lactation. Differences (BSH – HOL) for fat percentage were 0.21 ($P < 0.01$; I1), 0.20 ($P < 0.01$; I2), and 0.09 (NS; I3) in first lactations and 0.24 ($P < 0.01$; I1), 0.16 ($P < 0.10$, I2), and 0.15 (NS; I3) in second lactations. Protein (%) was significantly different ($P < 0.01$) during all sub-periods. In first and second lactation the differences were 0.17, 0.15, 0.12 and 0.12, 0.13, 0.11, for I1, I2, and I3. BSH had significantly ($P < 0.05$) lower SCS in first lactation in I1 (-0.41) and I2 (-0.32). The difference in I3 (-0.19) was not significant. In second lactation no significant differences were found for SCS between BSH and HOL.

CONCLUSIONS

BSH and pure Holsteins did not differ for daily milk (kg), fat (kg) and protein (kg) production during the first two lactations. The crosses were significantly different for fat percentage and protein percentage during the first two lactations. BSH tended to have lower SCS than pure HOL in first lactation.

F_1 crosses of Holstein dams and Brown Swiss sires proved to be competitive compared to pure Holsteins in an intensive environment. Minor differences between the breed groups were found within sub-periods of the course of the lactation. The results show that crosses produce less at the beginning of lactation and have more capacity for milk production at the end of first and second lactation.

ACKNOWLEDGEMENTS

The authors would like to thank Bernd Fischer and co-workers of the experimental station “Iden” for their assistance in data collection and care of the animals.

REFERENCES

Heins, B. J., L. B Hansen, A. J. Seykora, D. G. Johnson, J. G. Linn, J. E. Romano and A. R. Hazel. 2008. Crossbreds of Jersey × Holstein compared with pure Holsteins for production, fertility, and body and udder measurements during first lactation. J. Dairy Sci. 91:1270–1278

Mielenz, N., J. Spilke, H. Krejcova and L. Schüler. 2006. Statistical analysis of test-day milk yields using random regression models for the comparison of feeding groups during the lactation period. Archives of Animal Nutrition 60(5): 341 – 357

Table 1. Least square means, standard errors, and differences between breed groups for milk(kg), fat(kg), protein(kg), fat(%), protein(%) and SCS for daily production in first lactation for pure Holsteins and Brown Swiss × Holstein crossbreds.

Trait	Holstein	s.e.	BS x Holstein	s.e.	Difference
Cows	n = 50		n = 55		
Milk (kg)	28.77	0.83	28.28	0.79	-.49
Fat (kg)	1.18	0.03	1.19	0.03	+.01
Protein (kg)	0.98	0.03	1.00	0.03	+.02
Fat (%)	4.09	0.06	4.25 *	0.05	+.16
Protein (%)	3.57	0.03	3.71**	0.03	+.14
SCS	2.02	0.13	1.71 †	0.12	+.31

** p < 0.01, * p < 0.05, † p < 0.10, n = number of observations

Table 2. Least square means, standard errors, and differences between breed groups for milk(kg), fat(kg), protein(kg), fat(%), protein(%) and SCS for daily production in second lactation for pure Holsteins and Brown Swiss × Holstein crossbreds.

Trait	Holstein	s.e.	BS x Holstein	s.e.	Difference
Cows	n = 43		n = 46		
Milk (kg)	34.40	0.96	33.93	0.91	-.47
Fat (kg)	1.40	0.03	1.43	0.03	+.03
Protein (kg)	1.21	0.03	1.22	0.03	+.01
Fat (%)	4.15	0.07	4.33†	0.06	+.18
Protein (%)	3.58	0.03	3.70**	0.03	+.12
SCS	2.57	0.15	2.32	0.15	+.25

** p < 0.01, † p < 0.10, n = number of observations

Figure 1. Daily differences in milk production (kg) in first and second parity and the 95% confidence intervals between BS x Holstein crossbreds and pure Holsteins.