



Different parameters affecting body weights of Charolais and Limousine calves from birth to weaning

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ABSTRACT

Birth weight and body weight at the beginning, in the middle and at the end of grazing season of Charolais (312) and Limousine (167) calves at the Educational and Research Animal Husbandry Centre Logatec(Slovenia) born from 1995 to 2005 were analysed. Fixed effect of breed, sex, parity, year, age of calves and random animal effect were included. Breed, sex and year influenced birth weight and body weight at the beginning, in the middle and at the end of grazing season. Parity influenced only birth weight and body weight at the beginning of grazing season. Age of calves influenced body weight at the beginning and in the middle of grazing season, but this effect was not shown at the end of grazing season. Variance and covariance components for direct additive genetic effect were estimated by REML method in the VCE5 package. Estimated heritability for birth weight, body weight at the beginning, in the middle and at the end of grazing season were 0.62; 0.25; 0.25 and 0.26, respectively. Genetic correlation with birth weight for body weight at the beginning was 0.78, for body weight in the middle was 0.51 and for body weight at the end of grazing season was 0.40. (Keywords: Charolais, Limousine, calves, body weight, heritability)

INTRODUCTION

In Slovenia suckler cows represent about 40% of total cow population and the percent is still increasing. The most important reason for widening suckler herds is the introduction of milk quotas because of rapidly increasing milk production. Milk production per cow has always been very intensive and is still rising. Consequently, the number of dairy cows has reduced. It can be expected that less and less calves from milk herds will be suitable for beef production.

Besides providing quality beef, rearing of suckler cows has numerous macro-economical advantages in comparison to dairy production, namely milk market relief, rearing in marginal regions, preservation of population and cultural landscape and keeping the agricultural lands in function. From the point of view of sustainable agricultural production such rearing is really beneficial (Čepon and Žgur, 2001).

The most important product for sale from suckler herd is a weaned calf. High percent of weaned calves in herds, about 90–95%, is recommended. Culled cows represent just a small part of income. Weaned calves are very suitable for slaughter or for fattening. Consumers require ecological production of quality beef from cow-calf systems.

The aim of this study was to determine the environmental and genetic parameters influencing weaning weight (weight at the end of grazing season) of Charolais and Limousine calves from a suckler herd. Birth weight, weight at the beginning and weight in the middle of grazing season were also analysed.

MATERIALS AND METHODS

Our research included 312 Charolais (CHA) and 167 Limousine (LIM) calves reared on Educational and Research Animal Husbandry Centre Logatec (Slovenia). CHA calves were born in years 1995–2005, while LIM calves between 1996 and 2005. Cows in the herd calved in late winter or spring (January – June). The average grazing season (149.3 days) lasted from the beginning of May to the end of October. The end of grazing season coincided the weaning period/time. Weaned calves were on average 196.4 days old (6.5 months). In grazing season cows and calves had no additional concentrate, except mineral–vitamin mixture fed *ad libitum*.

Pedigree data included calves sires, dams and grandparents. Grand sires were known in 90% on a male side and in 100% on dam side. In the analysed period, 37 sires had offspring in the herd. This included sires for natural service as well as artificial insemination (AI). On average, sires of natural service had more offspring in herd than sires of AI.

Data on birth weight, weight at the beginning, in the middle and at the end of grazing season were analysed. Calves were weighed at the beginning (60.8 days of age), in the middle at the average age 135.9 days and at the end of grazing season at the average age of 196.4 days (*Table 1*).

Table 1

Descriptive statistics for body weights till weaning

Breed	Sex		BW (kg)	WB (kg)	WM (kg)	WE (kg)
Charolais	Male	n	160	116	115	125
		$\bar{x} \pm SD$	48.1 ± 6.6	100.1 ± 23.9	202.7 ± 50.5	270.6 ± 50.8
	Female	n	152	109	111	127
		$\bar{x} \pm SD$	45.9 ± 6.1	97.6 ± 23.0	194.5 ± 47.7	252.2 ± 52.5
Limousine	Male	n	71	37	62	61
		$\bar{x} \pm SD$	43.5 ± 4.4	89.2 ± 22.7	162.1 ± 51.1	214.0 ± 57.9
	Female	n	96	46	75	74
		$\bar{x} \pm SD$	41.0 ± 4.3	88.8 ± 21.4	150.3 ± 47.4	202.8 ± 46.5

BW: birth weight, WB: body weight at the beginning of grazing season, WM: body weight in the middle of grazing season, WE: body weight at the end of grazing season, n: number of calves, \bar{x} : mean, SD: standard deviation.

Based on preliminary analyses, different models were used for body weights analyses of calves. Interactions between different fixed effects were not significant. Main effects only were used for further analyses. The effects of breed, sex, parity and year as fixed effects were included in all models ([1], [2], [3], [4]).

Age of calves at the beginning, middle and the end of grazing season were included as linear regression in the models [2], [3], [4] for corresponding weights. Additionally, the age of calves at the beginning of grazing season was fitted in the models for weight in the middle and at the end of grazing season, since from previous analyses on our populations (Čepon, 1990; Čepon and Žgur, 2001) its effect was expected. Random animal effect was also included in all models ([1], [2], [3], [4]).

Fixed part of the model was analysed by GLM procedure of statistical package SAS/STAT (SAS Institute Inc., 2001). The general least square method was used for this. Variance and covariance components for direct additive genetic (animal) effect were estimated by REML method in the VCE5 package (Kovač *et al*, 2002). The model [1] was used for the estimation of birth weight, the model [2] for the estimation of weight at the beginning, the model [3] for the weight in the middle and the model [4] for the weight at the end of grazing season in the multiple trait analysis.

$$y_{ijkl} = \mu + B_i + S_j + C_k + Y_l + a_{ijkl} + e_{ijkl} \quad [1]$$

$$y_{ijklm} = \mu + B_i + S_j + C_k + Y_l + b_1(x_{ijklm} - \bar{x}) + a_{ijklm} + e_{ijklm} \quad [2]$$

$$y_{ijklm} = \mu + B_i + S_j + C_k + Y_l + b_1(x_{ijklm} - \bar{x}) + b_{11}(w_{ijklm} - \bar{w}) + a_{ijklm} + e_{ijklm} \quad [3]$$

$$y_{ijklm} = \mu + B_i + S_j + C_k + Y_l + b_1(x_{ijklm} - \bar{x}) + b_{11}(z_{ijklm} - \bar{z}) + a_{ijklm} + e_{ijklm} \quad [4]$$

Where:

y_{ijklm} = body weights (BW, WB, WM, WE) kg;

B_i = breed; $i = 1, 2$;

S_j = sex; $j = 1, 2$;

C_k = parity; $k = 1, \dots, 7$;

Y_l = year; $l = 1, \dots, 11$;

x_{ijklm} = age of calves at the beginning of grazing season, days;

w_{ijklm} = age of calves in the middle of grazing season, days;

z_{ijklm} = age of calves at the end of grazing season, days;

a_{ijklm} = direct additive genetic effect;

e_{ijklm} = residual.

RESULTS AND DISCUSSION

Analysis of variance for birth weight, weight at the beginning, in the middle and at the end of grazing season for the fixed part of models is shown in *Table 2*. Proportion of variability explained by Model 1 was 32%. Birth weight of Charolais and Limousine calves depended on the breed ($p < 0.001$), sex ($p < 0.001$), parity ($p = 0.036$) and year ($p < 0.001$). The difference in birth weight between Charolais (LSM=46.9 kg) and Limousine (LSM=41.3 kg) calves was 5.6 kg. Higher difference (7.6 kg) between BW of CHA (47.1 kg) and LIM (39.5 kg) calves in France was reported by *Phocas and Laloë* (2004). Similar results of the effect of year ($p < 0.001$), sex ($p = 0.002$), breed ($p < 0.001$) and parity ($p = 0.019$) were shown by *Čepón and Žgur* (2001) in previous analyses for calves born from 1996 to 2000 in the same herd. *Krupa et al.* (2005) also found that sex ($p < 0.001$) and breed ($p < 0.001$) affected birth weight of calves of various beef breeds in a field test (cow-calf grazing system) in Slovakia.

Model 2 was used to explain 59% of variability for weight at the beginning of grazing season, when calves were 60.8 days old. All included parameters (breed, sex, parity, year, age at the beginning of grazing season) affected weight at the beginning of grazing season. Charolais calves (LSM=97.9 kg) were 5.8 % heavier than Limousine (LSM=92.2 kg). Males (LSM=97.4 kg) were 4.7 kg heavier than females (LSM=92.7 kg).

Weighing in the middle of grazing season was performed at 135.9 days on average. Coefficient of determination in Model [3] was the highest (67%). Among all included

parameters parity did not affect on WM ($p=0.153$). Charolais calves weighted 203.4 kg (LSM) and Limousine 186.5 kg (LSM). *Krupa et al.* (2005) showed the effect of breed ($p<0.001$) and sex ($p<0.001$) on weight at 120 days at six beef breeds.

Variability explained for weight at the end of grazing season was 60%. The WE (196.4 days on average) corresponded weaning weight and depended on breed ($p<0.001$), sex ($p<0.001$) and year ($p<0.001$). The difference in WE between Charolais (LSM=266.8 kg) and Limousine (LSM=240.2 kg) calves was 26.6 kg. Males (LSM=263.7 kg) were 7.7% heavier than females (LSM=243.3 kg). *Makulska et al.* (2003) reported the following weight at 210 days of Charolais (253 kg) and Limousine (245 kg) calves in Poland. *Phocas and Laloë* (2004) found out weaning weight for CHA (279.8 kg) and for LIM (258.3 kg) from herds in France. *Goyache et al.* (2003) showed similar effect of sex ($p<0.001$) on weaning weight at the local Spanish beef breed called Asturiana de los Valles. *Krupa et al.* (2005) also reported the effects of breed ($p<0.001$) and sex ($p<0.001$) on weaning weight of beef calves. The age of calves at the beginning of grazing season did not affect the weights in the middle and at the end of grazing season, which was in the opposite of results from *Čepon* (1990) and *Čepon and Žgur* (2001).

Table 2

Analysis of variance for birth weight and body weight at the beginning, in the middle and the end of grazing season by GLM

Source of variability	d.f.	p – value			
		BW	WB	WM	WE
Breed	1	<0.001	0.009	<0.001	<0.001
Sex	1	<0.001	0.011	<0.001	<0.001
Parity	6	0.036	0.050	0.153	0.469
Year	10	<0.001	<0.001	<0.001	<0.001
Age (beginning)	1	-	<0.001	0.373	0.298
Age (middle)	1	-	-	0.038	-
Age (end)	1	-	-	-	0.558
R ²		0.32	0.59	0.67	0.60

BW: birth weight, WB: body weight at the beginning of grazing season, WM: body weight in the middle of grazing season, WE: body weight at the end of grazing season, d.f.: degrees of freedom, R²: coefficient of determination.

Genetic and phenotypic variance of BW, WB, WM and WE are presented in *Table 3*. Phenotypic variance of BW (30.72 kg²) is higher than those found by *Phocas and Laloë* (2004) for BW at CHA (20.0 kg²) and at LIM (7.5 kg²) calves. The same authors also reported about variance for weaning weight in CHA (1141 kg²) and in LIM (662 kg²) weaned calves which are very similar to our result (1102.33 kg²). Genetic and phenotypic standard deviations were computed for easier interpretation and comparison with literature. Genetic standard deviation was 4.35 kg, 7.67 kg, 13.28 kg and 17.11 kg for BW, WB, WM and WE, respectively. Lower genetic standard deviation for BW had Charolais (2.45 kg) and Limousine (1.70 kg) calves reared in Czech Republic (*Jakubec et al.*, 2003), who also had lower genetic SD for weight at 210 days (LIM; SD=14.51 kg) and similar SD to our result (CHA; SD=16.53 kg).

Table 3

Genetic variance, phenotypic variance, genetic covariance (above diagonal) and phenotypic covariance (below diagonal) between BW, WB, WM and WE

	σ_g^2 (kg ²)	σ_{ph}^2 (kg ²)	BW	WB	WM	WE
BW	18.97	30.72		26.13	29.56	29.55
WB	58.89	232.89	43.75		49.28	66.97
WM	176.13	700.69	46.76	266.78		209.59
WE	292.68	1102.33	49.71	268.68	705.81	

σ_g^2 : genetic variance, σ_{ph}^2 : phenotypic variance, BW: birth weight, WB: body weight at the beginning of grazing season, WM: body weight in the middle of grazing season, WE: body weight at the end of grazing season.

Phenotypic standard deviation was 5.54 kg, 15.26 kg, 26.47 kg and 33.20 kg for BW, WB, WM and WE. *Jakubec et al.* (2003) also reported similar phenotypic SD for BW at CHA (4.90 kg) and LIM (3.39 kg). Standard deviation for WE at CHA (33.05 kg) in LIM (29.01 kg) was also similar to our results. Phenotypic (above diagonal) and genetic (below diagonal) covariance are also shown in *Table 3*.

Heritability estimated in this study for BW, WB, WM, WE were 0.62; 0.25; 0.25; 0.26 and are shown on diagonal in *Table 4*. The highest values of heritability coefficient were estimated for BW (0.62). Heritabilities for WB, WM and WE were very similar. *Phocas and Laloë* (2004) estimated lower heritability for BW at CHA ($h^2=0.33$) and LIM ($h^2=0.38$), but *Crews et al.* (2004) estimated higher heritability for Canadian CHA ($h^2=0.53$). Differences among our results and literature exist because only one herd with very equal environment was included. Heritability of the similar traits for Angus (*Anonymous*, 2005a) was 0.38 for birth weight and 0.18 for the weight at 200 days. *Phocas and Laloë* (2004) estimated also heritability for weaning weight which was 0.13 (CHA) and 0.29 (LIM) and was similar to our results ($h^2=0.26$). Heritability for weight at 205 days at Canadian CHA was 0.22 (*Crews et al.*, 2004). Genetic correlations are presented above diagonal in *Table 4*. Genetic correlation between BW and WE was 0.40. In literature, 0.39 was reported for CHA and 0.44 for LIM (*Phocas and Laloë* (2004), and 0.66 for Angus cattle (*Anonymous*, 2005b). Between the WB, WM, WE, high genetic correlations were estimated.

Table 4

Heritability (on the diagonal) for birth weight, weight at the beginning, in the middle and the end of grazing season, genetics correlations (above diagonal) among them with standard errors

	BW	WB	WM	WE
BW	0.62 ± 0.07	0.78 ± 0.11	0.51 ± 0.14	0.40 ± 0.13
WB		0.25 ± 0.08	0.48 ± 0.19	0.51 ± 0.17
WM			0.25 ± 0.08	0.92 ± 0.07
WE				0.26 ± 0.07

BW: birth weight, WB: body weight at the beginning of grazing season, WM: body weight in the middle of grazing season, WE: body weight at the end of grazing season.

CONCLUSIONS

Birth weight, weight at the beginning, in the middle and the end of grazing season of Charolais and Limousine calves at the Educational and Research Animal Husbandry Centre Logatec were analysed. Fixed effect of breed, sex, parity, year, age of calves and random animal effect were included. Breed, sex and year influenced birth weight and weight at the beginning, in the middle and at the end of grazing season. Parity influenced only birth weight and weight at the beginning of grazing season. Age of calves at the beginning of grazing season influenced weight at the beginning, age of calves in the middle of grazing season influenced body weight in the middle of grazing season.

Genetic and phenotypic variance and covariance components for random animal effect were estimated and were in the same range as estimated (co)variance components from the literature. Estimated heritability for birth weight, weight at the beginning, in the middle and at the end of grazing season were 0.62; 0.25; 0.25 and 0.26, respectively. Genetic correlation with birth weight for weight at the beginning was 0.78, for weight in the middle was 0.51 and for weight at the end of grazing season was 0.40.

REFERENCES

- Anonymous (2005a). Heritabilities of traits in Angus GROUP BREEDPLAN, 2005-2006. Angus Society of Australia, <http://www.angusaustralia.com.au/Breedplan/Heritabilities.gif> (21. Apr 2006).
- Anonymous (2005b). Genetics Relationship between Traits, 2005-2006, Angus Society of Australia, http://www.angusaustralia.com.au/BP_Download_files.htm (21. Apr 2006).
- Crews, D.H. Jr., Lowerison, M., Caron, N., Kemp, R.A. (2004). Genetics parameters among growth and carcass traits of Canadian Charolais cattle, *Canadian Journal of Animal Science*. 84. 4. 589-597.
- Čepon, M. (1990). Nekateri vplivi na priraste telet krav dojilj, *Zb. Bioteh. fak. Univ. Edvarda Kardelja Ljublj., Živin.*, 56. 25-40.
- Čepon, M., Žgur, S. (2001). Effect of sex and successive calving on growth rate of Charolais and Limousine calves from birth to weaning, *Zb. Bioteh. Fak. Univ. Ljublj., Kmet. Supl.*, 31. 175-182.
- Goyache, F., Fernández, I., Royo, L.J., Álvarez, I., Gutiérrez, J.P. (2003). Factors affecting actual weaning weight, preweaning average daily gain and relative growth rate in Asturiana de los Valles beef cattle breed, *Arch. Tierz.*, 46. 3. 235-243.
- Jakubec, V., Schlote, W., Řiha, J., Majzlík, I. (2003). Comparison of growth traits of eight beef cattle breeds in the Czech Republic, *Arch. Tierz.*, 46. 2. 143-153.
- Kovač, M., Groeneveld, E., Garcíá-Cortés, L.A. (2002). VCE-5, a package for the estimation of dispersion parameters. 7th World Congress on Genetics Applied to Livestock Production. Montpellier. 33. 741-742.
- Krupa, E., Oracová, M., Polák, P., Huba, J., Krupová, Z. (2005). Factors affecting growth traits of beef cattle breeds raised in Slovakia, *Czech J. Anim. Sci.*, 50. 1. 14-21.
- Makulska, J., Weglarz, A., Zapletal, P. (2003). Beef production from Limousine and Charolais suckler cows under various climatic conditions in Poland. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*. Brno, 51. 3. 69-74.

- Phocas, F., Laloč, D. (2004). Genetic parameters for birth and weaning traits in French specialized beef cattle breeds. *Livestock Production Science*. 89. 121-128.
- SAS Institute Inc. (2001). *The SAS System for Windows, Release 8.02*. SAS Institute Inc., Cary, NC.

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