Analysis of Growth Traits in Calves of Charolais in Different Breeding Conditions

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Abstract

The issue was solved by the growth of 632 Charolais calves born between 2011 and 2016 from three farms in the Slovak Republic who are part of performance beef cattle testing. In our work was evaluated a live birth weight, weight at 120 days of age, weight at 210 days of age, weight at age 365 days, average daily gain from birth to 120 days of age, average daily gain between 120 and 210 days of age and average daily gain up to 365 days. Assessment factors were selected by breeder, sex of calves, calf birth year, calf birth month and sire effect. Evaluating of the live weight at birth founded the highest weight of farm A (42.92 kg), which is closest to the breed standard. Heaviest calves were born in 2016 with very high significant effect ($p<0.001$) on the birth weight. Male calves were heavier than heifers in single, heifer twins were also heavier. High statistical significance ($p<0.001$) was detected by sire. In our work we´ve founded the best weaning weight 229.11 kg in lower birth weight (33.52 kg). This indicator reduced over the years up to year 2016, when the weight raised again. Heifers reached higher values than bulls (203.74 kg compared to 177.40 kg), while the impact of this factor was statistically significant ($p<0.05$). The highest calves weaning weight was found in the October (224.35 kg) and the January (209.98 kg). We also investigated the correlation dependence of growth characteristics, when we found a positive correlation dependence ($r = 0.03$) between weaning weight and birth weight, which is statistically not significant ($p>0.05$).

Keywords: growth indicators, Charolais, live weight, performance testing, weaning weight

1. Introduction

A good calves' growth ability is a decisive factor in the profitability of suckles cow's herds and also determines the breeder´s satisfaction in creating purchase prices. This value is expressed mainly with the average daily gain (ADG) as well as with actual weight of calves under one year of age. Gains point to rate of adjustment in the concrete breed to the farming conditions in Slovakia. The breeding of Charolais in Slovakia has started after 1992 in agrarian-trading cooperative Skalica by imports of embryos from USA. Nowadays, Charolais is one of the most powerful beef breeds in our country with a performance comparable with advanced breeders [1].

According to Brown [2], is the live birth weight one of the most important profitable factors of beef herds. Determining the exact birth weight is important to judge calving ease since it depends on birth weight. Likewise is one of the best traits for sire selection. As Sagebiel et al. [3] found, charolais sires markedly increase the birth weight of calves in crossbreeding and also lengthen gravidity in purebred mating.

Similarly can be the final weight affected by individual genetic basis relating to its breed [4-6]. Calves growth efficiency and their weaning weight are affected by many factors including the

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sex [6, 7], year and season of birth [8, 9], dam´s age [6, 9-11] etc. According to Chenette, Frahm [12] is possible to estimate maternal properties of cows and growth abilities of calves in pursuance of weaning weight. Difference between sexes could be adjusted according to constant age of calves and mother´s maturity. The cow´s weight at maturity has strong relationship with calves' growth potential, which can attain the sales weight earlier.

Overall, growth is the best economical measurement, unless individual consumption of feed is available [13]. The efficiency of the breeding will always be a summary of factors that determine on the one hand the own costs and the purchase prices of weaned calves on the other hand. Careful monitoring of growth, reproductive and productive performance in concretely habitat under farmer´s condition is necessary to capture a full picture about beef contribution [14].

The aim of this work was to evaluate and compare growth indicators of Charolais calves in different farming condition in Slovakia. At the same time we determined influence of selected factors on growth parameters of calves and young beef. Paper also examines calving and productive age of cows within individual breeders.

2. Materials and methods

The data set consisted of records of 272 bulls and 328 heifers of charolais breed. Animals were born from 2011 to 2016 in three different farming conditions in Slovakia (A -77 calves, B – 528 calves, C – 27 calves). Data were collected from database of Breeding Service of Slovak republic [15]. The growth control has been evaluated based on the birth weight (LBW), weight at 120 days (LW120), weight at 210 days – weaning weight (LW210) and weight at 365 days (LW365) according to the union of cattle breeders in Slovakia (ZCHMD). We have also determined the average daily gain from born to 120 days (ADG1), pre-weaning average daily gain (ADG2) and post-weaning average daily gain (ADG3). We have verified impact of factors: herd, sex, birth year, birth month and sire.

Farm A is located in region Podpoľanie in the southern part of central Slovakia at an altitude 669 m above sea level (m.a.s.l.). The company disposes with 300 ha of permanent grasslands and pastures. Animals are pasture housed in summer pasture season. In the winter period they are sheltered in the barns. They have own forage (silage, hay) which are feeding to animals *ad libitum*. The major area is classified under per-warm and per-humid zone with the average total annual rainfall over 600 mm per year. The mean annual temperature is 7.8 °C. The soil type includes fluval soil, sandy loam and clay.

District of farm B is classified under per-warm to per-cold zone and per-humid climatic condition. Region Šariš is located in altitude 323 m.a.s.l. in the northern part of eastern Slovakia. The total average rainfall is 760 mm per year and the average annual temperature of the district is 7.5 °C. The soil type includes cambisol and fluval soil. During the summer season (May-October) are animals pastured and then they are housed in barns and fed with hay, grass silage and core mixture.

Farm C is ecological focused company in the east of Slovakia. The area is classified under cold and humid climatic condition. Its altitude is 459 m about sea level and the average total annual rainfall is 619 mm. The mean annual temperature is 7.6 °C and the predominant soil types of the area include fluval soil and deep clay loam. Animals are housed in the barn with access to fenced pasture near the farm. The forage base consists mainly of hay and grass silage.

For the processing of the growth and fattening indicators was made the basic and statistical characteristics using the Statistical Analysis System, version 9.4 (TS1M2) Enterprise Guide 5.4. [16]. The fixed effect of breeder (A - south of central Slovakia, B - north-eastern Slovakia, C - eastern Slovakia), sex of calves (bulls, heifers), year of birth (2011, 2012, 2013, 2014, 2015, 2016), birth month (winter [December-February], spring [March-May], summer [June-August], autumn [September-November]) and sire on growth indicators were investigated. Furthermore, single factor analysis of variance (ANOVA) and Pearson´s correlation coefficients of basic growth indicators were calculated.

The impact of selected factors on higher mentioned growth parameters was assessed with the mixed model equation:

$$Y_{ijklm} = \mu + B_i + Sx_j + Y_k + M_l + SOr_m + e_{ijklm}$$

, where: $Y_{ijklm}$is the observation on weight at different ages and weight gains, μ is the overall mean, B_i is the fixed effect of *i*th breeder, Sx_j is

the fixed effect of *j*th sex of calves, Y_k is the fixed effect of the *k*th year of birth, M_l is the fixed effect of *l*th month of birth, SOr_m is the fixed effect of *m*th sires´origin, $e_{ijklm}$is the effect of random error.

3. Results and discussion

The overall least squares means and standard errors observed for BLW, LW120, LW210 and LW365 were 35.19 ± 4.74 kg, 128.60 ± 56.30 kg, 189.89 ± 98.66 kg, 191.01 ± 167.36 kg. In the whole file was the average birth live weight 31.02 kg varied from 29.15 (B) to the highest average value 42.92 kg (A). Our results showed highest birth weights for bulls (P<0.001) in selected breeders. According to several authors males of the most farm animals grow faster and attain maturity earlier than females. Sexual dimorphism in this case was 6.98 % (A), 6.69 % (B) and 6.84 % (C). Ndofor-Foleng et al. [17] ascribe a higher males´ values due to hormonal differences in endocrine and physiological functions.

The results of our work for BLW (31.02 kg) shown in Table 1 are different from those of Mujibi and Crews [18], who mention the average birth weight 46.54 kg and Szabolcs et al. [4] for 34.83 kg. Authors consider this value to be the highest with other beef breeds and also statistically similar to the calves of Limousine and Blonde d´ Aquitaine.

Table 1. The effect of the gender on investigated traits in selected herds

Effects		n[1]	BLW (kg)	LW120 (kg)	LW210 (kg)	LW365 (kg)	ADG1 (kg)	ADG2 (kg)	ADG3 (kg)
			LSM[2] ± SD[3]	LSM[2] ± SD[3]	LSM[2] ± SD[3]	LSM[2] ± SD[3]	LSM[2] ± SD[3]	LSM[2] ± SD[3]	LSM[2] ± SD[3]
Farm A	♂	30	44.83±9.78	116.5±44.74	157.83±91.42	-	0.70	1.05	1.21
	♀	47	41.7±9.11	125.21±30.13	191.91±73.63	217.02±113.51	0.73	0.99	0.55
overall		77	42.92±9.44	121.82±36.49	178.64±82.16	142.79±138.10	0.71	1.02	0.88
Farm B	♂	223	30.65±1.03	126.29±50.28	153.09±105.86	-	0.93	1.21	0.92
	♀	273	28.6±1.06	104.71±51.17	171.56±80.75	214.34±142.53	0.81	1.11	0.84
overall		528	29.15±2.07	114.36±51.22	161.91±93.26	119.68±149.48	0.87	1.16	0.88
Farm C	♂	19	34.21±2.42	158.84±81.28	321.26±143.94	322.05±232.36	1.29	1.61	1.25
	♀	8	31.88±2.80	127.75±81.99	247.75±12.21	283.25±175.69	1.18	1.34	0.87
overall		27	33.52±2.71	149.63±81.20	329.11±120.56	310.55±214.51	1.24	1.47	1.06

[1]number of observations, [2] least squares means, [3]standard deviation

These differences in accordance with various authors are significant for the survival during the pre-weaning period as well as for the growth rate before weaning, which is higher for Charolais and beef Simmental calves [19, 4, 20 and 21]. The strongest growth intensity we saw for males in farm C where a difference between birth weight and weight at 120 days was 124.63 kg. Differential growth of heifers at age 120 days was recorded in farm A, where we found the average weight 125.21 kg with variability 24.26 % whereas for bulls it was 116.5 kg with variability 38.4 %. In other farms was observed the trend of higher growth for bulls. In accordance with our findings bulls of various breeds were heavier than heifers [22, 5 and 19]. The lowest average values for LW210 was observed in farm B for bulls (153.09 kg) and heifers (171.56 kg). We can state positive results in world trend for the weaning weight (P<0.01) in average 182 kg [6] even its improvement in farm C. After the weaning we determined the increased weight of heifers against bulls 34.08 kg (A), 18.47 kg (B) and 26.49 kg (C). Our results are partially confirmed by [23] that bulls of Charolais breed attained higher values for the birth weight than heifers of the same breed (P<0.01). In this study we mentioned higher weaning weight of females, in average 203.74 kg. Özlütürk et al. [7] reported significantly higher birth weight, weight at 205 days, ADG before weaning and also better body measurements for bulls.

We found higher weight gains represented in Table 1, from birth to age 120 days for bulls in all

monitored farms with the highest average value 1290.38 g (C). The highest daily gain was recorded in both genders in farm C from age 120 to 210 days (1.61 kg. resp. 1.34 kg). Furthermore we found significant influence of the sex on ADG1 but non-significant impact on ADG2 and ADG3.

Table 2. The effect of the birth month on investigated traits in monitored file

Effects	n[1]	BLW (kg)	LW120 (kg)	LW210 (kg)	LW365 (kg)
		LSM[2] ± SD[3]	LSM[2] ± SD[3]	LSM[2] ± SD[3]	LSM[2] ± SD[3]
January	83	34.78±4.61	123.82±50.73	209.98±128.12	317.46±96.72
February	100	36.10±4.34	124.39±44.45	198.96±82.56	205.49±162.47
March	109	34.12±5.33	120.68±57.47	216.78±61.82	193.78±106.76
April	68	34.00±3.72	149.83±28.44	193.18±65.15	123.50±174.67
May	38	37.37±1.64	169.74±56.23	139.52±113.22	141.26±200.24
June	21	29.33±1.83	160.48±33.87	129.05±94.74	170.48±156.68
July	14	34.00±1.45	157.50±30.40	165.38±61.88	235.25±85.99
August	16	32.13±0.79	128.67±18.70	193.50±40.80	375.00
September	51	29.10±2.77	116.18±27.60	122.25±104.13	-
October	68	39.38±1.26	144.21±12.75	224.35±33.47	208.06±131.95
November	46	29.13±1.31	89.20±58.15	155.87±79.39	209.35±143.13
December	18	32.88±1.42	120.50±30.42	152.54±112.29	203.62±152.28

[1]number of observations, [2] least squares means, [3]standard deviation

Pursuant to the effect of birth month of calves (Table 2) we found most calves born in March (17.25 %) and least in July (2.22 %). The trait BLW attained best results for calves born in October (55 kg –A; 39.38 kg –C) and July (30 kg – B). Lightest calves were born in months July, September, November and December (P>0.05).

These results are inconsistent with those of Stonehouse et al. [24] who presented the higher birth weight in winter. Spring, resp. summer calves were heaviest in LW120 (P<0.001) - 135.55 kg, 266.5 kg, 160.48 kg. The highest value at the weaning (P<0.01) was recorded for calves born in March (289.75 kg) which is in accordance with findings of Griffin et al. [25]. Tatman et al. [8] did not detect any differences in ADGs of Brahman bulls born in spring or fall. However, bulls born in autumn reached puberty later. We found the highest ADG1 in calves born in spring and summer months, similarly as in Griffin et al. [25]. Authors Sasaki et al. [26] connect the calving season with the reproductive performance, i.e. occurrence of dystokia and stillborn calves born in spring (March – May) and winter months (December – February).

Table 3 represents evaluation the effect of year of birth. We found quite balanced values over the years for breeders B and C. In the farm A we determined marked increase in weight with the progressing year, where we marked the highest average weight 49.25 kg in 2015 whereas in 2012 it was only 29.74 kg. The indicator live weight at 120 days showed fluctuating values in herd A and B, only herd C recorded gradually increases over the years. An antagonistic effect for breeder C has the weaning weight which evidently declined throughout the years (301.80 kg in 2011 resp. 103.33 kg in 2015).

For all growth indicators we found a significant impact of the birth year (P<0.001).

Table 3. The effect of the year of birth on investigated traits in monitored file

Effects	n[1]	BLW (kg) LSM[2] ± SD[3]	LW120 (kg) LSM[2] ± SD[3]	LW210 (kg) LSM[2] ± SD[3]	LW365 (kg) LSM[2] ± SD[3]
2011	55	29.60±2.41	117.35±44.47	194.16±66.92	259.38±135.71
2012	142	28.94±2.45	122.54±45.46	184.35±81.71	125.18±158.27
2013	125	30.82±4.84	110.01±58.32	167.92±95.20	142.66±154.47
2014	86	30.72±6.11	92.50±65.41	113.31±113.03	145.70±150.65
2015	129	32.64±7.80	116.53±52.70	161.71±94.26	142.95±160.86
2016	95	33.26±7.68	139.05±21.17	178.74±87.81	-

[1]number of observations, [2] least squares means, [3]standard deviation

Table 4 describes the effect of the calves´ sires. In this case we found the highest average BLW value 50 kg from CHS612 (farm A) and the lowest average value 27 kg from LIV589 (farm B). Offspring of the most used sire in farm A (CHV957) attained the mean value 48 kg which corresponds to the breeds´standard of Charolais breed. In trait LW120 we found heaviest calves (178 kg and 180 kg) from French origin sire VCH010 (farm C) and from unknown bull IL 000 (farm A). Contrariwise lightest values 90 kg we found in farm A (ZTI320). Offspring from this bull were also lightest at the weaning (155 kg) based on what we can mark it as a worsening sire in growth traits. The high weight at weaning (390 and in average 362 kg) we determined in French origin sires VCH027 and VCH010 (farm C). The highest value at age 365 days (592 kg) reached offspring of VCH018 (farm C).

Table 4. The effect of the sire and its origin on investigated traits in selected herds

	Effects	origin	n[1]	BLW (kg) LSM[2] ± SD[3]	LW120 (kg) LSM[2] ± SD[3]	LW210 (kg) LSM[2] ± SD[3]	LW365 (kg) LSM[2] ± SD[3]
Farm A	CHM770	SK	21	45.71±6.38	123.81±19.87	221.27±25.41	-
	CHV597	SK	5	48.00±4.47	133.00±13.96	132.00±121.17	177.00±161.93
	CHV957	SK	30	48.00±6.90	113.67±37.64	160.50±101.86	225.83±109.12
	IL 000	-	17	30.88±5.07	129.41±52.62	168.24±69.17	161.18±128.20
Farm B	CHM786	SK	7	29.14±1.68	125.00±10.80	140.00±97.34	98.57±170.34
	CHV853	SK	330	29.18±2.07	113.47±54.50	165.67±94.09	126.86±152.65
	CHV924	SK	34	29.35±1.94	105.00±51.49	151.03±90.36	88.68±132.03
	CHV925	SK	154	29.06±2.14	117.65±45.12	156.46±92.98	108.73±144.31
Farm C	CHM741	SK	6	34.17±2.04	174.00±103.66	142.33±156.69	68.83±168.61
	CHM742	SK	3	33.33±2.89	173.67±20.50	316.33±52.08	191.00±330.82
	CHV980	SK	7	33.71±2.81	168.43±80.85	238.43±18.26	407.86±29.23
	VCH027	FR	5	32.00±2.74	159.80±15.94	317.80±59.48	444.80±78.26

[1]number of observations, [2] least squares means, [3]standard deviation

World trends dealing with the bull selection points to more masculine type of phenotype resulting with uniform gestation length, easy calving, birth weight and also weaning weight. These can be confirmed with our findings. All the same the selection pressure is stronger in males than females [15]. We saw highest ADG1 (1.47 kg) in offspring of CHM741 (farm C). On the contrary lowest values (0.50 kg) from bull ZTI320 (farm A), bull VCH010 (farm C) proved to be the best sire for average daily gains before weaning (2.04 kg) while for gains up to one year we found in VCH018 (farm C). The lowest weight gains showed offspring of sire ZTI219 (0.28 kg) before weaning, resp. sire ZTI555 (0.42 kg) up to one year of age. The strong statistical significance of the sire for BLW and LW365 and significant impact for LW120 and LW210 is confirmed by authors [7].

4. Conclusions

According to the influence of selected factors in this paper it can be concluded that the growth performance of Charolais calves kept in different conditions in Slovakia was significantly influenced by gender, birth month and birth year as well as sire. The highest BLW value was found in farm A (42.92 kg) which has a beneficial effect on later growth. Pursuant to the sex were 272 bulls, 328 heifers and 32 twins determined. The higher live weight was determined in BLW, LW210 and LW365 days of age. At the age 120 days we found higher weight (125.21 kg) for heifers in farm A. Exactly the weaning weight has economic importance of the sales product. Based on its evaluation it is also possible to estimate cow´s maternal abilities and growth potential of calves for selection guidance. The year of birth changed values stronger in heifers than bulls. The difference between sex can be adjusted based on the constant age of calves and maturity of mothers. During the evaluation the influence of birth month we determined the most calves born in March (17.25%) and least number in July (2.22%).

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