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The Intensity of MLLT Area Changes and Development of the Selected Body Parts Muscling in Bulls and Heifers of Blonde d' Aquitaine Cattle and its Crossbreeds During Rearing Period

Research Article

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ABSTRACT

The objective of this work was to determine the effect of sex, breed and birth season of calves on intensity of MLLT (musculus longissimus lumborum et thoracis) area changes and development of the selected body parts in bulls and heifers of Blonde d´Aquitaine (BA) cattle during rearing period. Two generations of bulls (n=63) and heifers (n=68) of Blonde d´Aquitaine (n=61) and crossbreds C×BA (C-Czech Fleckvieh) (n=70) born from December 2004 to June 2006 were evaluated. MLLT area measurements and subjective evaluations of 3 basic body areas muscling (shoulder, back and rump) on live animals were performed at 120, 210 and 365 days of animal age. Statistically significant differences were determined in shoulder, back, and rump muscling in relation to animal sex in favor of bulls at 120 and 210 days of age (P<0.01 to P<0.001). Purebred animals achieved significantly higher muscling of rump at 120 days, and muscling of rump and back at 210 days (P<0.05 to P<0.001). Statistically significant differences were determined in animals muscling in relation to birth season (P<0.05 to P<0.001). Results indicate the best growth ability of purebred bulls born from the end of year to March. Breeders can use this fact as a recommendation for modification of breeding and mating system of beef cattle to achieve better encashment of slaughtered animals.

KEY WORDS birth season, breed, muscling score, musculus longissimus lumborum et thoracis, sex.

INTRODUCTION

It is impossible to measure carcass traits on live animals. Ultrasound is very perspective method for estimation of muscling and fattiness on live animals due to its mobility, price and usability in practice. Progeny testing or completing selection schemes by traits which determined beef production on live animals are necessary for increasing muscling and beef carcass quality.

Blonde d´Aquitaine (BA) is a breed from France with a high body frame. The live weight of the animals ranges from 800 kg to 1100 kg in cows and from 1200 kg to 1500 kg in bulls. It is a breed with good development of the skeleton, excellent muscling, position and formation of the limbs. BA is very popular in France (470,000 cows bred in 2004), but the population in the Czech Republic is very low because of the relatively short history of breeding. Purebreds and crossbreeds with other beef and dual-purpose breeds are bred in herds of suckler cows in the Czech Republic (Zahrádková *et al.* 2009). This is one reason for breeders´ increasing interest in recent times.

Czech Fleckvieh (C) is a dual-purpose breed which is bred on dairy farms and in suckler herds in the Czech Republic as well. The live weight of the animals ranges from

650 to 750 kg in cows and from 1200 to 1300 kg in bulls. The Czech population of the Fleckvieh breed represents the 3rd highest population in the EU. The dual-purpose of dams enables a good rate of calf growth in relation to high milk production of cows, as well as fattening to a live weight of approximately 600 kg with a high quality of carcass (Bouška *et al*. 2006). Czech Fleckvieh cows represent a significant part of the suckler cow population in the Czech Republic (Zahrádková *et al*. 2009).

The MLLT area and fattiness are usually measured on the 12th rib. The area is used for prediction of the whole beef yield. It is very difficult to achieve high accuracy of MLLT area measurement than fattiness because area is double-proportioned. Correlation between ultrasound and carcass measurement varied from 0.69 (Realini *et al*. 2001), 0.85 (Waldner *et al*. 1992) to 0.95 (Perkins *et al*. 1997).

Average of absolute differences between ultrasound and carcass measurement of MLLT area were to 7.09 cm^2 (Perkins *et al*. 1992) or to 2.9 cm^2 (Realini *et al*. 2001).

Polák and Daňo (2002) stated indicators of growth including MLLT area changes measured by ultrasound. They described possibility of using ultrasound as an effective method in carcass bulls' classification. Stádník *et al*. (2009) reported significant relationships among lumbar region width, back muscling, and MLLT area and the possibilities for actual muscling valuation during rearing of animals.

Mc Laren *et al*. (1991), Bullock *et al*. (1991), and Grings *et al*. (1996) performed ultrasound evaluation of MLLT area and fattiness in bulls and cows of different breeds. They found that prediction accuracy of carcass composition is variable and depends on kind of farm animal. Correlation coefficients for cattle fattiness r=0.45-0.96 and for MLLT area 0.20-0.94 were determined by them.

Nová *et al*. (2002) compared Charolais, Hereford and Aberdeen-Angus growth abilities measured by ultrasound. They mentioned the highest value of half perimeter of thigh and MLLT height on the 1st and 6th lumbar vertebra in Charolais at 210 days of age. On the contrary, the fattiness was the highest in Herefod and the lowest in Charolais cattle. Toušová *et al*. (2009) evaluated effect of selected factors on growth ability and carcass quality in the same breed.

Kolářský *et al*. (2004) reviewed growth ability of Hereford bulls in relation to their live weight and to 6 body parameters. They evaluated muscling by ultrasound measurement of MLLT area and measured 68.5 cm^2 or 57.4 cm^2 of MLLT area in progeny bulls and 64.2 cm^2 or 53.1 cm^2 in fattened bulls on the 1st respectively on the 6th lumbar vertebra at 360 days of age.

The objective of this work was to determine effect of sex, breed and birth season of calves on intensity of MLLT area changes and development of the selected body parts in bulls and heifers of Blonde d´Aquitaine cattle during rearing period. The second objective was to determine relationship among shoulder, back, and rump muscling, and MLLT area on the 1st and 6th lumbar vertebra at 120, 210 and 365 days of age.

MATERIALS AND METHODS

Two generations of bulls (n=63) and heifers (n=68) of Blonde d´ Aquitaine (n=61) and crossbreds (n=70) born from December 2004 to June 2006 were evaluated. Monitored groups of bulls and heifers was housed in the new reconstructed stable at groups by 20 animals and fed by feed ration based on the basic components (silage with higher percent of dry matter, hay or straw) only during winter period (from November to April). All animals; cows, bulls, and observed calves too, were kept in pasture area during whole grazing period (from May to October). Calves stayed together with cows in the herd to the end of pasture season. The breeding system in the herd involves seasonal mating and calving in winter period (from December to June).

MLLT area measurements were performed on 120, 210 and 365 days of animal age by ALOKA SSD-500 ultrasound equipped with a 3.5-MHz 17.2 cm linear array probe UST5011U-3.5. The transducer was positioned laterally to the 1st and 6th lumbar vertebra on the left side of animal. Ultrasound examination of MLLT was recorded with DVD recorder Panasonic DMR-EH55 to digital quality of images for analyses with Lucia 4.1 software (Laboratory Imaging s.r.o.) as follows. The quality of acquired images was affected by application of sufficient quantity of vegetable oil and ultrasound gel on coat of animals before investigation of MLLT area. The merging of 2 images was necessary for the measurement of MLLT area at 210 and 365 days of age.

Subjective evaluations of 3 basic body areas muscling (shoulder, back and rump) on live animals at 120, 210 and 365 days of their age were realized. Evaluations were performed by classifier of Czech Beef Breeders Association in relation to Methodology of linear description of body exterior from 1996. The highest muscling was evaluated by 10 points and the lowest muscling by 1 point.

The dataset was analyzed by ANOVA through the statistical program SAS STAT 8.0-GLM. The following linear model was used to evaluate the effect of sex, breed, and birth season on shoulder, back, and rump muscling and MLLT area at 120, 210 and 365 days of animal's age:

$$Y_{ijkl} = \mu + SEX_i + BREED_j + BS_k + bmA + e_{ijkl}$$

Where; Y_{ijkl}, is observed value of the shoulder, back, and rump muscling and MLLT area at 120, 210 and 365 days of animals age; μ, is average value of depenent variable; SE-

X_i, fixed effect of i-th class of animal sex (i=♀ or ♂); $BREED_j$, fixed effect of j-th class of animal breed (j=BA or C×BA); BS_k, fixed effect of k-th class of birth season (k=December to March or April to June); bmA, regression to the animal age at the measurement; e_{ijkl}, residual effects (random error).

Differences between estimated variables were tested on the levels of significance P<0.05 (*), P<0.01 (**) and P<0.001 (***).

RESULTS AND DISCUSSION

Table 1 contains results of muscling and MLLT area in relation to animal sex. Statistically significant differences were determined in shoulder, back, and rump muscling in relation to animal sex at 120 and 210 days of age (P<0.01 to P<0.001).

Differences were from 0.7 to 0.9 point of shoulder muscling, from 0.5 to 0.7 point of back muscling, and from 0.6 to 0.7 point of rump muscling in favor of bulls at 120 and 210 days of age, respectively. Differences measured at 365 days of age was from 0.02 to 0.19 point and non-significant.

days of age (P<0.001). The lower amounts of traits observed in crossbreed animals during our study were related to dual purpose of C breed. Our results indicate significantly lower gain of animals´ muscling caused by crossbreeding of BA and C breeds in comparison to gain achieved due to pure breeding of beef breed. Nová *et al.* (1997) measured higher values of rump muscling in pu rebred calves. These facts document higher selection intensity of beef breeds focused to traits of beef production includes muscling and better possibility of carcass encashment under SEUROP system, which includes muscling traits as an important part of price determination.

Significant differences were not determined in MLLT area of both groups at 120 and 365 days of age. Statistically significant difference 3.4 cm^2 (P<0.05) was detected in MLLT area on 1st lumbar vertebra in favor of purebred animals only at 210 days of age. Quantitative and qualitative attributes of MLLT are evaluated for better possibilities of selection and beef realization in market (Šubrt *et al.* 2002; Kolářský *et al.* 2004; Bukač *et al.* 2005).

Table 3 demonstrates expressive differences (P<0.05 to P<0.001) of shoulder, back, and rump muscling from 1.5 to 1.9 point at 120 days of age, which were determined in fav-

Table 1 Effect of animal sex to muscling of shoulder, back, and rump and MLLT area on the 1st and 6th lumbar vertebra

	Days of age	♀ n=68 μ+α	♀ n=68 SE	♂ n=63 μ+α	♂ n=63 SE	P
Muscle score of shoulder (point)	120 days	5.0	0.25	5.9	0.24	***
	210 days	6.4	0.21	7.1	0.20	***
	365 days	6.3	0.18	6.5	0.17	0.261
Muscle score of back (point)	120 days	5.2	0.22	5.9	0.21	***
	210 days	6.4	0.18	6.9	0.17	***
	365 days	6.5	0.18	6.5	0.17	0.920
Muscle score of rump (point)	120 days	5.5	0.27	6.2	0.26	**
	210 days	6.7	0.26	7.3	0.24	***
	365 days	6.4	0.19	6.6	0.18	0.278
MLLT area 1st lumbar vertebra (cm^2)	120 days	42.9	1.52	45.1	1.44	0.106
	210 days	53.0	2.06	55.6	1.89	0.121
	365 days	65.4	2.13	65.2	1.95	0.916
MLLT area 6th lumbar vertebra (cm^2)	120 days	38.6	1.21	41.6	1.14	**
	210 days	48.6	1.72	50.7	1.58	0.124
	365 days	59.9	1.95	61.7	1.79	0.266

P= levels of statistical significances of differences between groups: P<0.05 (*), P<0.01 (**), and P<0.001 (***).

Measurement of MLLT area indicated significant difference 3.0 cm^2 in favor of bulls, when measurement was performed on the 6th lumbar vertebra at 120 days of age only. Other differences, from 1.9 to 2.1 cm^2, measured on the 1st and 6th lumbar vertebra, were not statistically significant. Our findings agreed with those of Crews *et al.* (2002), who stated significant effect of age and sex to MLLT area.

Table 2 shows the effect of breed to muscling and MLLT area. Purebred animals achieved significantly higher muscling of rump by 0.7 point at 120 days (P<0.05), and by 0.7 point of rump muscling (P<0.01) and by 0.4 point of back muscling at 210 days (P<0.05) and from 0.6 point of shoulder and back muscling to 1.0 point of rump muscling at 365

or of calves born from April to June. This fact is confirmed by the higher growth and muscling at 120 days of calves born in the beginning of the pasture season, which is related to the higher level of dams´ milk production after transfer of the herd to the pasture area. Contrary tendency was detected at 210 and 365 days of age, when calves born from December to March achieved higher level of muscling from 0.4 to 1.5 point. These calves demonstrated higher utilization of pasture nutrients, which is related to higher age and the beginning of rearing during the winter period.

On the other hand, a completely different trend was detected in the MLLT1 and MLLT 6 area as well. We documented a smaller area at 120 days of age and a larger area

Table 2 Effect of animal breed to muscling of shoulder, back, and rump and MLLT area on the 1st and 6th lumbar vertebra

	Days of age	BA n=61		C×BA n=70		P
		μ+α	SE	μ+α	SE	
Muscle score of shoulder (point)	120 days	5.6	0.24	5.3	0.26	0.139
	210 days	6.9	0.20	6.6	0.22	0.065
	365 days	6.7	0.16	6.1	0.19	***
Muscle score of back (point)	120 days	5.7	0.20	5.4	0.23	0.073
	210 days	6.8	0.17	6.4	0.19	*
	365 days	6.8	0.16	6.2	0.19	***
Muscle score of rump (point)	120 days	6.2	0.25	5.5	0.28	*
	210 days	7.4	0.24	6.7	0.26	**
	365 days	7.0	0.18	6.0	0.21	***
MLLT area 1st lumbar vertebra (cm^2)	120 days	44.9	1.41	42.9	1.57	0.149
	210 days	56.0	1.89	52.6	2.10	*
	365 days	66.2	1.90	64.3	2.20	0.297
MLLT area 6th lumbar vertebra (cm^2)	120 days	40.7	1.12	39.4	1.25	0.255
	210 days	50.7	1.58	48.6	1.75	0.163
	365 days	61.9	1.76	59.7	2.02	0.187

P= levels of statistical significances of differences between groups: P<0.05 (*), P<0.01 (**), and P<0.001 (***).

at 210 and 365 days of age in calves born from April to June. However, the differences were not significant, except for the difference in the MLLT1 at 210 days of age. The higher degree of muscling and simultaneously the smaller area of the MLLT at 120 days in calves born from April to June could be related to higher milk production of cows during the beginning pasture season, which causes an increase in calves´ fattiness. A contrary trend at 210 and 365 days of age documents the use of these fat reserves in the body for continuous growth in the period when cows´ milk production declines and a change of feed ration is necessary.

A lower level of shoulder, back, and rump muscling observed at 365 days of age is related to the end of the pasture season and transfer of the herd to the stable for the winter period in the Czech Republic. It causes significant changes and lower quality of feed ration. A significant portion of calves is sold at the age from 7 to 10 months. This fact emphasizes the importance of the results described at 120 and 210 days of age in relation to encashment of live animals.

Table 4 illustrates Pearson correlation coefficients among muscling of shoulder, back, and rump and MLLT area measured on the 1st and 6th lumbar vertebra.

Significances of correlation coefficients are indicative of relations among shoulder, back and rump muscling and MLLT area on the 1st and 6th lumbar vertebra at 120, 210 and 365 days of age, respectively (P<0.05 to P<0.001). Values of coefficients and their significance decline in relation to length of prediction period.

Prediction of MLLT area on the 1st and 6th lumbar vertebra at 210 days respectively at 365 days of age in relation to muscling at 120 days of age was determined by correlation coefficients r=0.53 to 0.58 (P<0.001) respectively r=0.17 to 0.29 (P<0.05 to P<0.001). When relations were detected for MLLT area at 365 days in relation to muscling at 210 days of age, correlations from r=0.17 to r=0.21 (P<0.05) were determined.

Relations of MLLT area at 210 respectively 365 days of

Table 3 Effect of birth season of calves to muscling of shoulder, back, and rump and MLLT area on the 1st and 6th lumbar vertebra

	Days of age	December-March n=44		April-June n=87		P
		μ+α	SE	μ+α	SE	
Muscle score of shoulder (point)	120 days	4.6	0.27	6.3	0.25	***
	210 days	6.9	0.22	6.5	0.19	*
	365 days	6.7	0.16	6.2	0.17	*
Muscle score of back (point)	120 days	4.6	0.23	6.5	0.21	***
	210 days	6.9	0.20	6.4	0.18	*
	365 days	6.6	0.19	6.3	0.17	0.862
Muscle score of rump (point)	120 days	5.1	0.28	6.6	0.26	***
	210 days	7.3	0.27	6.8	0.24	0.073
	365 days	6.8	0.21	6.3	0.19	**
MLLT area 1st lumbar vertebra (cm^2)	120 days	44.4	1.59	43.5	1.47	0.550
	210 days	52.1	2.19	56.4	1.92	*
	365 days	64.3	2.25	66.3	2.01	0.350
MLLT area 6th lumbar vertebra (cm^2)	120 days	45.4	0.65	44.5	0.61	0.159
	210 days	48.1	1.84	51.2	1.60	0.068
	365 days	60.3	2.06	61.3	1.84	0.602

P= levels of statistical significances of differences between groups: P<0.05 (*), P<0.01 (**), and P<0.001 (***).

Table 4 Correlation coefficients among muscling of shoulder, back, and rump and MLLT area on the 1st and 6th lumbar vertebra

		210 days					365 days				
		SH (point)	BA (point)	RU (point)	MLLT1 (cm^2)	MLLT6 (cm^2)	SH (point)	BA (point)	RU (point)	MLLT1 (cm^2)	MLLT6 (cm^2)
120 days	SH (point)	0.53^{***}	0.31^{***}	0.46^{***}	0.59^{***}	0.58^{***}	0.10	0.18^{*}	0.22^{**}	0.30^{***}	0.22^{*}
	BA (point)	0.41^{***}	0.26^{**}	0.39^{***}	0.55^{***}	0.53^{***}	0.10	0.21^{*}	0.19^{*}	0.28^{**}	0.17^{*}
	RU (point)	0.51^{***}	0.34^{***}	0.53^{***}	0.55^{***}	0.54^{***}	0.17^{*}	0.27^{**}	0.34^{***}	0.29^{***}	0.23^{**}
	MLLT1 (cm^2)	0.18^{*}	0.14^{*}	0.23^{**}	0.33^{***}	0.37^{***}	0.22^{*}	0.23^{**}	0.32^{***}	0.03	-0.04
	MLLT6 (cm^2)	0.28^{**}	0.25^{**}	0.29^{***}	0.38^{***}	0.44^{***}	0.13	0.16	0.26^{**}	-0.01	-0.12
210 days	SH (point)	-	-	-	-	-	0.21^{*}	0.20^{*}	0.34^{***}	0.20^{*}	0.21^{*}
	BA (point)	-	-	-	-	-	0.25^{**}	0.26^{**}	0.35^{***}	0.03	0.10
	RU (point)	-	-	-	-	-	0.27^{**}	0.27^{**}	0.43^{***}	0.17^{*}	0.18^{*}
	MLLT1 (cm^2)	-	-	-	-	-	0.20^{*}	0.25^{**}	0.21^{*}	0.08	0.00
	MLLT6 (cm^2)	-	-	-	-	-	0.16	0.16	0.17	0.01	-0.10

*, **, *** -levels of statistical significances of correlation coefficients: P<0.05 (*), P<0.01 (**) and P<0.001 (***).

SH-Muscle score of shoulder, BA-Muscle score of back, RU-Muscle score of rump, MLLT1-MLLT area 1st lumbar vertebra, MLLT6-MLLT area 6th lumbar vertebra.

age with MLLT area at 120 days of age are documented by correlation coefficients r=0.33 to 0.44 (P<0.001) respectively r=−0.12 to 0.03 (P>0.05). Relations of MLLT area at 365 days with MLLT area at 210 days of age varied from r=−0.10 to 0.08 (P>0.05).

CONCLUSION

The significant effects of sex, breed and birth season on the intensity of MLLT area changes and development of selected body parts in bulls and heifers (BA, BA×C) during the rearing period were determined. The results indicate the best growth ability of purebred bulls born from the end of year to March. Breeders can use this fact as a recommendation for timing, and for modification of the breeding and mating system of beef cattle under condition in the Czech Republic to achieve better possibilities of the slaughtered animals' encashment.

They can start with the use of sexed semen, for example, or with changes in the time schedule of the mating period. The results documented a decline of accuracy in relation to the length of the period in which growth ability is predicted, because the correlation coefficient decreased in accordance with longer periods of prediction. These results can contribute to the increase of the BA cattle population with the aim of producing high quality beef carcass.

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