EFFECT OF GENOTYPE ON GROWTH INTENSITY AND MEAT QUALITY OF BULLS

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Summary. The objective of this study was to investigate the effect of genotype on growth intensity and meat quality of Aubrac, Limousine, Lithuanian Black-and-White, Lithuanian Black-and-White x Limousine, Lithuanian Red, Lithuanian Red x Simmental, Charolais and Simmental breed bulls. Two bulls from each breed (8 breeds in total) were selected. From each bull offspring 4 calves were randomly selected (n=64). The study was performed at the Šilutė control bulls feeding station. The animals were fed a standard feed regimen and the ration was adjusted according to body weight. The feeding of bulls offspring was performed from 210 to 500 days of age. The diet consisted of hay, silage, pelleted feed, minerals and vitamins. The bulls were weighed on arrival, then every other month, and at the end of experiment. Meat quality analysis of cattle performed by a commonly used methods. Caloric value of meat was counted according Watt & Mersil [1975] formula. It was shown, that growth intensity and amount of intramuscular fat in different breed cattle was variable. The highest increase of live weight (LW) was registered in Aubrac breed, while lowest LW in Lithuanian Red breed. Meat from Lithuanian Red x Simmental crossbreed had the highest amount of intramuscular fat and higher caloric value. Intramuscular fat and meat shear force correlation coefficients were highly positive and statistically significant in Lithuanian Red and Lithuanian Red x Simmental crossbreeds. In cattle of Aubrac breed and Lithuanian Black-and-White x Limousin crossbreeds highly significant negative correlation of intramuscular fat and increase of LW was registered. These results suggested that a genetic variation among different cattle breeds had influence on meat quality and live weight.
Keywords: genotype, live weight, meat quality, bulls.

BULIŲ GENOTIPO ĮTAKA AUGIMO INTENSYVUMUI IR MĖSOS KOKYBEI

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Santrauka. Straipsnyje pateikti tyrimų duomenys apie įvairių genotipų bulių augimo intensyvumą ir mėsos kokybę. Tyrimui buvo atrinkti Aubrakų, Limuzino, Lietuvos juodmargių, Lietuvos juodmargių x Limuzino, Lietuvos žalųjų, Lietuvos žalųjų x Simentalio, Šarolė ir Simentalio veislių buliai, kiekvienos veislės dviejų bulių palikuonys. Analizei naudoti keturi kiekvieno buliaus palikuonys. Visi UAB „Šilutės veislininkystė“ gyvuliai buvo auginti vienodomis šėrimo ir laikymo sąlygomis. Šėrimo kontrolė atlikta nuo 210 iki 500 amžiaus dienos. Buliai vertinti kas 2 mėnesius pagal šėrimo kontrolę. Tirtų buliukų vidutinė raciono struktūra pagal maistingumą buvo tokia: kombinuotieji pašarai sudarė 37,5 proc., šienas – 16 proc., silosas – 46,5 proc., žali proteinai sudarė 12,3 proc. raciono SM, krakmolas – 10,1 proc., cukrūs – 6,9 proc., žalia ląsteliena – 21,4 proc. 1 kg raciono SM vidutiniškai buvo 8 MJ AE. Mėsos kokybės tyrimai atlikti pagal bendrai priimtas metodikas. Mėsos kaloringumo vertė skaičiuota pagal Watt ir Mersil (1975) formulę.

Bandymai parodė, kad nevienodas tarpraumeninių riebalų kiekis buvo įvairaus galvijų genotipo mėsoje. Lietuvos žalųjų x Simentalio mišrūnų mėsa turėjo daugiau tarpraumeninių riebalų ir buvo kaloringesnė. Nevienodas buvo ir skirtingo genotipo galvijų augimo intensyvumas. Didžiausias priesvoris buvo Aubrakų veislės, o mažiausias – Lietuvos žalųjų veislės palikuonių. Teigiama ir statistiškai reikšminga koreliacija nustatyta tarp tarpraumeninių riebalų kiekio ir mėsos kietumo Lietuvos žalųjų veislės palikuonių ir Lietuvos žalųjų x Simentalio mišrūnų. Statistiškai reikšminga neigiama koreliacija tarp tarpraumeninių riebalų kiekio ir priesvorio per parą nustatyta Aubrakų veislės palikuonių ir Lietuvos juodmargių x Limuzino mišrūnų. Tyrimų duomenys parodė, kad bulių genotipai turėjo įtakos mėsos kokybei ir priesvoriui per parą.
Raktažodžiai: buliai, genotipas, priesvoris, mėsos kokybė.

Introduction. Meat, a concentrated nutrient source, was traditionally considered essential for optimal growth and development. The daily ration of human must be not less than 50 g adipose [Culioli et al., 2003]. The fat in meat supplies fatty acids and vitamins and plays an essential role in the sensory perception of juiciness, flavour and texture. However, fat has more than double calorific value of protein and carbohydrates [Papadima & Bloukas 1999; Chizzolini et al., 1999]. Fat in meat can be present as intramuscular fat (between the muscles), intramuscular fat (or marbling, i. e. within the muscles) and subcutaneous fat under the skin. With increased age and animal weight

the proportion of fat tissue changes [Johnson et al., 1972]. The growth of different fat depots is not uniform by intramuscular and subcutaneous fat [Serdaroglu, 2006; Žgur, 2007].

Fat deposit is important as an energy store and reserve for breeding cattle and as a component of carcasses of slaughter cattle [Abraham et al., 1980]. Cattle breed is one of important factors that affect fat tissue distribution [Chambaz et al., 2002]. At the same weight and degree of fatness, different breeds may have different proportions of intramuscular, intermuscular and subcutaneous fat. Researchers Williams [1978] and Žgur [2007] assessed that beef breeds (Hereford, Angus, Simmental) deposit more subcutaneous and less intramuscular fat than dairy breeds. Meat quality of beef breeds has been measured and compared in numerous studies [Chambaz et al., 2001; Chambaz et al., 2003; Tokusoglu & Kemal Unal 2003; Dufey & Chambaz 2004]. Very important index of meat quality is shear force. Meat with the fat deposited within the steak to create a "marbled" appearance has always been regarded as more tender than steaks where the fat is in a layer around the outside [Thomson & Dobie 1997; Morgan et al. 2002]. The lowering of fat content in fresh meat and in meat products is analysed in relation to the proposed aim of reducing calorific value. Intramuscular fat and protein amount had the most influence on calorific value of meat [Chizzolini et al., 1999].

The objective of this study was to investigate the effect of genotype on growth intensity and meat quality in eight different breed bulls offspring.

Material and Methods. The experiment was carried out with beef breeds: Limousine (LI), Aubrac (AU), Charolais (CHA), Simmental (SI) and crossbreeds: Lithuanian Black-and- White x Limousine (LBxLI), Lithuanian Red x Simmental (SIxLR) and dairy breeds: Black-and-White (LB), Lithuanian Red (LR). Two bulls from each breed (8 breed in total) were selected. From each bull offspring 4 calves were randomly selected (n=64). The study was performed at the Šilutė control bulls feeding station. The animals were fed a standard feed regimen and the ration was adjusted according to body weight. The feeding of bulls offspring was performed from 210 to 500 days of age. The diet consisted of hay, silage pelleted feed, minerals and vitamins. The bulls were weighed on arrival, then every other month, and at the end of experiment.

The meat samples were taken from the *musculus longissimus dorsi* between 12th and last ribs. The meat quality evaluated 48 h after slaughter. Intramuscular fat content % and shear force (kg/cm^2) of meat were evaluated by a standard methods: fat by an automatic system for fat extraction Soxterm SE 416 macro (ISO 1443; 1973 - Meat and meat products determination of total fat content), shear force – according to Warner-Bratzler method, protein of meat was evaluated according to Kjeldal method, ash – by organic matter incineration at 700°C.

Total calorific value (kcal) were calculated using the Atwater method. The following equation was used for calculation (Watt & Mersil, 1975): $K= [(F_p \times P) + (F_l \times L) + (F_c \times C)]$, where K is the calorie; F the multiplication factor for each component (F_p : 4.27 for protein, F_l : 9.02 for lipid, F_c : 4.10 for carbohydrate); P the protein content (g/100 g); C the carbohydrate content (g/100 g) and L the lipid content (g/100 g). Carbohydrate contents were estimated by difference (DM –fat- protein = carbohydrate)

Statistical analysis. All calculations were performed using the R statistical package version 2.0.1. (Gentlemen and Ihaka, 1997).

Results and Discussion. This experiment demonstrated that intramuscular fat content in meat of different genotype offspring was variable. The highest content of intramuscular fat was found in meat of Lithuanian Red x Simmental crossbreeds (Table 1). The differences of intramuscular fat index in Lithuanian Red x Simmental crossbreeds and other genotypes were as follows: offspring of Aubrac breed 0.80%, Lithuanian Black-and-White 0.64%, Simmental 0.78% ($p < 0.05$), Limousin 1.0% ($p < 0.01$) and offspring of Charolais breed 1.13% ($p < 0.001$). Meanwhile, intramuscular fat content in Lithuanian Black -and- White x Limousin crossbreds was statistically significant higher ($p < 0.01$) compared to purebred Charolais offspring. Our results are in concert with results of Žgur & Čepon [2007], who found a significant differences in the amount of intramuscular fat between different beef and dairy cattle breeds. It was shown, that in beef breeds fat deposit was more subcutaneous and less intramuscular compared to cattle of dairy breeds. Further, in the present study it was shown that calorific value of meat in different breeds varied from 107 to 127 kcal/100 g. The highest meat calorific value was registered in Lithuanian Red x Simmental crossbreeds which was on 10.5 kcal/100 g ($p < 0.05$), 15.0 kcal/100 g ($p < 0.01$), 15.7 kcal/100 g ($p < 0.01$) and 19.2 kcal/100 g ($p < 0.001$) higher compared to Lithuanian Black-and-White, Aubrac, Simmental and Charolais breeds, respectively. The lowest calorific value of meat was registered in offspring of pure-bred Charolais (107 kcal/100g). The statistically higher significant difference of calorific value of meat between Lithuanian Black-and-White X Limousin crossbreds 18.56% and Lithuanian Red offsprings 14.58% ($p < 0.001$), and Lithuanian Black-and-Whites was registered. The results on correlation of meat calorific value with the amount of intramuscular fat are in agreement with other researchers [Cengiz & Gokoglu, 2005]. Furthermore, cattle genotype had influence on shear force of meat. The highest value of shear force was registered in meat of Simmental breed offspring, however, the lowest was found in Lithuanian Red x Simmental crossbreeds. Statistically significant differences of meat shear force were estimated between Simmental and Aubrac breed offsprings, Limousin breed, Lithuanian Red breed ($p < 0.05$), Lithuanian Black-and-White breed, Lithuanian Black-and-White x Limousin crossbreeds ($p < 0.01$) and Lithuanian Red x Simmental crossbreeds ($p < 0.001$). These resuls are in agreement with findings of Chambaz et. al. [2003], who reported the differences in meat quality between Angus and Limousin breeds, and Simmental breed.

Table 1. **Quality of meat from bulls of different genotype, intramuscular fat content, calorific value, shear force and live weight per day**

Breeds	Intramuscular fat, (%)	Calorific value, (kcal/100g)	Shear force, (kg/cm^2)	Live weight per day, (g)
Aubrac (AU)	1.96±0.142 * LRxSI,	111.90±1.694 **LBxLI	1.76±0.163 *SI	1283.5±51.26 *LJ, SI, ***LI, LR, LRxSI
Limousin (LI)	1.71±0.187 **LRxSI	110.51±4.735	1.82±0.286 *SI	897.4±62.54 *LBxLI, CH, SI, ***AU
Lithuanian Black-and-White (LB)	2.12±0.182 *LRxSI, **CH	116.48±1.711 *LBxLI	1.53±0.204 **SI	1040.4±20.69 *AU, **LI
Lithuanian Black-and-White x Limousin (LBxLI)	2.03±0.207 **CH	126.26±5.203 SA***	1.68±0.156 **SI	1149.1±48.09 *LR, **LRxSI, ***LI
Lithuanian Red (LR)	2.32±0.131 ***CH	122.28±4.402 **SI, ***CH	1.96±0.313 *LRxSI, SI	759.0±96.93 **LB, ***AU, LBxLI, CH, SI
Lithuanian Red x Simmental (LRxSI)	2.76±0.219 *AB, LJ, SI **LI, ***CH	126.97±1.145 *LJ, **AB, SI, ***CH	1.00±0.113 *LR, CH, ***SI	809.0±269.72 **LBxLI, CH, SI, ***AU
Charolais (CHA)	1.63±0.194 **LB, LBxLI, ***LR, LRxSI	107.70±1.650 ***LBxLI, LR	2.09±0.214 *LRxSI	1163.5±37.79 *LR, **LRxSI, ***LI
Simmental (SI)	1.98±0.203 *LRxSI	111.26±2.437 ** LBxLI, LR	2.67±0.367 *AU, LI, LR, **LB, LBxLI, ***LRxSI	1135.9±35.49 *LR, AU, **LRxSI, ***LI
Total	1.98±0.077	116.65±1.403	1.87±0.100	1044.4±32.94

* - P<0.05; ** - P<0.01; *** - P<0.001

Growth intensity in different breed of cattle was unequal. The highest increase of live weight was registered in Aubrac breed, which was on 524g/day higher compared to Lithuanian Red breed offspring (p <0.001). Furthermore, Aubrac breed offspring live weight per day was on 243 g/day, Simmental breed on 147 g/day (p <0.05), Limousin on 386/day g , Lithuanian Red on 524 g/day and Lithuanian Red x Simmental crossbreeds on 474 g/day (p <0.001) higher compared to Lithuanian Black-and-White breed. This results are in concert with findings of Krupa et. al. [2005], who pointed that growth intensity was significantly different in offspring of cattle with different genotype.

The correlation coefficient between increase of live weight per day, meat intramuscular fat (%), calorific value and shear force is presented in Table 2. It was shown statistically significant (p <0.05) negative correlation in meat intarmuscular fat content and live weight per day in Aubrac breed (r = –0.722) and Lithuanian Black-and-White x Limousin crossbreeds (r = –0.927) (p <0.001). The correlation coefficients of other genotypes were lower and not statistically significant (p >0.05).

It was established statistically significant (p <0.05) negative correlation in increase of live weight per day and meat calorific value between Limousin (r = –0.771) and Lithuanian Black-and-White breed offsprings (r = –0.412). Furthermore, statistically significant positive correlation between meat calorific value and intramuscular fat content between Lithuanian Black-and-White (r = 0.584; p <0.001) and Simmental (r = 0.767; p <0.05) breed offspring was registered. In addition, correlation coefficients were highly positive in meat intramuscular fat content and shear force between Lithuanian Red breed (p <0.001), Lithuanian Red x Simmental crossbreeds (p <0.05) and Lithuanian Blac-and-White breeds. It was shown that jointed genotypes index correlation coefficient between intarmuscular fat amount and shear force was close to 0. This finding could be to explained according Zajas [1981], who reported that intramuscular fat have no influence on meat tenderness of cattle <18 months age. These studies also documented that cattle meat marbling influence on meat tenderness is common in cattle of >2 years of age. Several authors observed that meat shear force have significant influence on amount of connective tissue, structure, myofibril system and other factors [Sharthose & Harris 1984; Purslow et al. 2005].

The overall results of the present study showed that animal genotype had influence on intramuscular fat level, shear force of meat and live weight. The highest intramuscular fat content was appeared in Lithuanian Red x Simmental crossbreds (2.76 %), and the lowest in Charolais breed offspring (1.63 %). The highest value of shear force was registered in Simmental breed offspring, while the lowest shear force of meat in Lithuanian Red x Sim-

mental crossbreeds. The highest increase of live weight was found in Aubrac breed cattle, while lowest in Lithuanian Red breed offspring. The present study emphasizes that genotype of cattle appeared to correlate with increase of live weight, meat shear force and intramuscular fat content. Furthermore, highly significant negative correlation between intramuscular fat content and increase of live weight in Aubrac offspring (r = -0722) and Lithuanian Black-and-White x Limousin cross-breeds (r = -0927) (p <0.001) was registered. In addition, highly positive correlation and statistically significant difference between intramuscular fat and meat hardness in Lithuanian Red and Lithuanian Red x Simmental crossbreds (p <0.001 - <0.05).

Table 2. **Correlation coefficient between live weight, intramuscular fat, calorific value and shear force of meat**

Aubrac breed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.550	0.301	-0.722*
Calorific value, (kcal/100 g)	–	0.264	-0.017
Shear force, (kg/cm^2)	–	–	0.165
Limousin breed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.155	-0.237	0.356
Calorific value, (kcal/100 g)	–	0.768*	-0.771*
Shear force, (kg/cm^2)	–	–	-0.049
Lithuanian Black-and-White breed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.570***	-0.575	-0.162
Calorific value, (kcal/100 g)	–	-0.322	-0.412*
Shear force, (kg/cm^2)	–	–	0.007
Lithuanian Black-and-White x Limousin crossbreed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.584	-0.127	-0.927***
Calorific value, (kcal/100 g)	–	0.094	-0.6
Shear force, (kg/cm^2)	–	–	0.239
Lithuanian Red breed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.652	0.930***	-0.259
Calorific value, (kcal/100 g)	–	0.588	-0.516
Shear force, (kg/cm^2)	–	–	-0.135
Lithuanian Red x Simmental crossbreed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.146	0.984*	0.692
Calorific value, (kcal/100 g)	–	0.166	0.786
Shear force, (kg/cm^2)	–	–	0.66
Charolais breed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.379	0.225	0.584
Calorific value, (kcal/100 g)	–	-0.365	0.819
Shear force, (kg/cm^2)	–	–	0.055
Simmental breed			
	Calorific value, (kcal/100 g)	Shear force, (kg/cm^2)	Overweight per day, (g)
Intramuscular fat, (%)	0.417*	-0.16	0.565
Calorific value, (kcal/100 g)	–	0.266	0.235
Shear force, (kg/cm^2)	–	–	-0.157

* - P<0.05; ** - P<0.01; *** - P<0.001

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