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PHENOTYPIC CHARACTERISTICS OF CHEMICAL COMPOSITION OF *M. LONGISSIMUS DORSI* IN CROATIAN SIMMENTAL BULLS

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SUMMARY

Simmental breed is known as a dual purpose breed widely spread in the Republic of Croatia. It represents more than two thirds of overall cattle population in Croatia. In this experiment we have focused on chemical components (dry matter, water, protein, fat and ash) in musculus longissimus dorsi (MLD) and its phenotypic characteristics. The trial comprised 710 young bulls, the progeny of sires chosen for artificial insemination (AI), during the period of 13 years.

Average chemical composition of MLD was as follows: dry matter 24,87±0,04%, water 75,13±0,04%, protein 20,66±0,05%, fat (ether extract) 3,12±0,06% and ash 1,10±0,002%. We have calculated phenotypic correlations among chemical components and analyzed various influences for all components. All calculations were made in SAS 8.0 (Statistical Analysis System) and Statistica 7.1. Phenotypic correlations between dry matter and water, protein, fat and ash were -1,000, 0,159, 0,533 and -0,164 respectively. Correlations between water and protein, fat and ash were -0,159, -0,533 and 0,164 respectively. Correlation coefficient between protein and fat was -0,750; between protein and ash -0,026 and between fat and ash -0,113. All correlations were significant ($p<0,01$) except between protein and ash. Influence of year, season, month and sire on chemical composition of MLD was significant ($p < 0,001$).

Phenotypic correlations estimates indicate that investi-

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gated traits could be used for selection of AI bulls.

Key words: *Simmental cattle, meat, chemical composition, phenotypic correlations*

INTRODUCTION

Simmental breed is known as a dual purpose breed widely spread in the Republic of Croatia. It represents more than two thirds (72,3%; CLC, 2007) of overall cattle population in Croatia. In this experiment we have focused on chemical components (dry matter, water, protein, fat and ash) of *musculus longissimus dorsi* (MLD) and its phenotypic characteristics. MLD was chosen because it is the largest and longest muscle in the body (König and Liebich, 2001) and because of its high commercial value. Chemical composition of meat affects meat quality, while proteolysis of myofibrillar proteins is considered to be the main biochemical factor contributing variation in meat tenderness (Koohmaraie et al., 2002). Testing AI bulls on chemical composition of MLD is used to improve meat quality. It's important to know how individual components are connected to each other. There are evidence of different influences on meat quality like sire, breed, muscle fiber characteristics and other (Maher et al., 2004). It is important to find out which factors predominantly influence chemical composition of MLD. Variability for beef eating quality is high we will try to find out how year and season of fattening influence MLD chemical components. In this article we will present our findings which, we hope, will elucidate before mentioned questions for Simmental breed.

MATERIALS AND METHODS

The trial comprised 710 young bulls, the progeny of AI sires during the period of 13 years (from 1993 till 2005). Young bulls were sons of 69 sires in progeny test for meat quality. Young bulls were placed in test station Hrsovo at approximately same age (60 days). After 15 days of accommodation and 45 days of preparation they were put in controlled fattening at the age of 120 days. Fattening period lasted on average 300 days.

Young bulls were kept in loose housing system and fed with concentrates and hay (60% energy from concentrate diets). Water was available "*ad libitum*".

At the end of fattening and before slaughter the animals fasted 12 hours. They were weighted twice, at the end of fattening and in slaughter house. In our investigation we included just weight at the end of fattening. After 24 hours of chilling, 7th to 9th thoracic rib cut was taken from the right carcass side.

Thoracic rib cuts were anatomically dissected and share of each tissue determined (Rako, 1960). Part of MLD (approximately 100 grams) was taken for chemical analysis. Sample was grinded several times. Water was evaporated at 100°C till the constant weight. The nitrogen content was determined by the standard Kjeldahl procedure and expressed as protein content (multiplied by 6,25). Fat percentage was determined by the Soxhlet method using petrol ether extraction. Ash was determined by burning at 610°C (Križanović, 1990).

SAS 8.0 and Statistica 7.1 software were used for all data analysis. Analysis of variance was performed for year, month and season in which fattening ended. Season included: winter from January to March, spring from April to June, summer from July to September and autumn from October to December. Relations among variables were tested by means of linear correlation. Regression analysis was applied for significant correlations. Influence of various factors on variables was tested by analysis of variance.

RESULTS AND DISCUSSION

Young bulls had higher average final weight (Table 1) in comparison with the weights of other similar experiments (Božić, 2001; Križanović, 1990; Karadjole, 1978). In those experiments final weight was from 436,6 to 533,7 kg. This increase of final weight shows the improvement of the selection process in approaching the goal of higher final weights proclaimed by the National cattle breeding plan (Group of authors, 1991).

The goal of the National cattle breeding plan is final weight between 550 and 600 kg. Earlier final weights in similar experiments, as mentioned before, showed that this improvement happened in investigated period from 1993 till 2005. Variability of considered trait was low.

Values for the most MLD chemical components were in accordance with the other authors except

▼ **Table 1.** Basic statistics for young bulls' final weight and MLD chemical composition
▼ **Tablica 1.** Osnovna statistika završne mase junadi i pokazatelja kemijskog sastava MLD

TRAIT / OBILJEŽJE	N	$X \pm s_x$	s	min.	max. / maks.	CV / KV%
FINAL WEIGHT / ZAVRŠNA MASA kg	710	575,20±2,134	56,86	395,00	731,00	9,89
DRY MATTER / SUHA TVAR %	710	24,87±0,040	1,06	21,82	29,50	4,27
WATER / VODA%	710	75,13±0,040	1,06	70,50	78,18	1,41
PROTEIN / BJELANČEVINE %	710	20,66±0,051	1,37	17,10	23,99	6,62
FAT / MAST%	710	3,12±0,060	1,60	0,11	9,94	51,16
ASH / PEPEO%	710	1,10±0,002	0,04	0,69	1,37	3,89

for protein and fat (Karadjole, 1978; Mikulec et al., 1978; Križanović, 1990; Božić, 2001). In those trials values for dry matter, water, protein, fat and ash were within ranges: for dry matter 24,37 to 25,37 %, water 74,63 to 75,63 %, protein 21,83 to 22,36 %, fat 1,37 to 2,04 % and ash 1,08 to 1,13 %. While most of the components showed very low variability, fat content showed very high variability in all trials. In our experiment protein content was lower and fat higher than in before mentioned experiments. This fact could be explained by higher final weight (Sazili et al., 2004; Patterson et al., 2004; Fiems et al., 2003; Carstens et al., 1991; Rompala et al., 1985 and Karadjole et al., 1979). Higher final weight is connected with higher accretion of fat tissue, increased body fat percentage and in the same time lowered share of the other components (Rompala et al., 1985).

Božić (2001) and Karadjole (1978) stated that various factors such as year, month and season could influence the fattening capacity and chemical composition of Simmental bulls. Our findings also showed that these influences are significant for most of investigated parameters. We tested those influences with analysis of variance (Table 2).

Influence of sire on investigated traits was significant as shown in table 2. Year, season and month of fattening could influence MLD composition through intensity of metabolic activity (Karadjole, 1978). It is known that during colder period of the year animal uses more of food energy for body temperature maintenance.

All correlations were significant, positive or negative, except the correlation between ash and protein, which was not statistically significant. Relatively high and negative (-0,750) correlation between protein and fat implicates, that higher accretion of muscle fat goes at the expense of protein content. Increased intramuscular fat may contribute to the juiciness of

▼ **Tablica 2.** Influence of year, month and season on bulls' final weight and MLD chemical composition
▼ **Table 2.** Utjecaj godine, mjeseca i sezone završetka tova na završnu masu junadi i pokazatelje kemijskog sastava MLD

FACTOR TRAIT /	SIRE / BIK		YEAR / GODINA		SEASON / SEZONA		MONTH / MJESEC	
UTJECAJ OBILJEŽJA	F	p	F	p	F	p	F	p
FINAL WEIGHT / ZAVRŠNA MASA kg	3,805	0,0001	12,032	0,0001	4,120	0,0001	4,475	0,0001
DRY MATTER / SUHA TVAR %	5,052	0,0001	6,249	0,0003	5,061	0,0001	4,670	0,0001
WATER / VODA %	5,052	0,0001	6,249	0,0003	5,061	0,0001	4,670	0,0001
PROTEIN / BJELANČEVINE %	17,379	0,0001	5,771	0,0007	22,304	0,0001	19,201	0,0001
FAT / MAST %	12,492	0,0001	2,534	0,0559	15,725	0,0001	13,492	0,0001
ASH / PEPEO %	4,848	0,0001	15,798	0,0001	5,419	0,0001	8,179	0,0001

Tablica 3. Linear phenotypic correlations among bulls' final weight and MLD chemical components
Table 3. Linearne fenotipske korelacije između završne mase junadi u tovu i pokazatelja kemijskog sastava MLD

	FINAL WEIGHT / ZAVRŠNA MASA kg	DRY MATTER / SUHA TVAR %	WATER / VODA %	PROTEIN / BJELANČEVINE %	FAT / MAST %	ASH / PEPEO%
FINAL WEIGHT / ZAVRŠNA MASA kg		0,286*	-0,286*	0,161*	0,055	-0,081
DRY MATTER / SUHA TVAR %	0,286*		-1,000*	0,159*	0,533*	-0,164*
WATER / VODA %	-0,286*	-1,000*		-0,159*	-0,533*	0,164*
PROTEIN / BJELANČEVINE %	0,161*	0,159*	-0,159*		-0,750*	-0,026
FAT / MAST %	0,055	0,533*	-0,533*	-0,750*		-0,113*
ASH / PEPEO %	-0,081	-0,164*	0,164*	-0,026	-0,113*	

meat and improve eating quality.

These findings are in accordance with other works (Božić, 2001; Križanović, 1993).

For high, statistically significant correlations we calculated regression formulas.

Simple linear regression between fat and dry matter, water and protein share in MLD with corresponding correlation coefficient (r), coefficient of determination (r^2) and probability level (p):

DRY MATTER (%) = 23,767 + 0,35434 * FAT (%)
r = 0,533; r^2 = 0,2841; p<0,0001

WATER (%) = 76,233 - 0,3543 * FAT (%)
r = -0,533; r^2 = 0,2841; p<0,0001

PROTEIN (%) = 22,661 - 0,6426 * FAT (%)
r = -0,750; r^2 = 0,5629; p<0,0001

Simple linear regression between bulls' final weight and dry matter and water share in MLD with corresponding correlation coefficient (r), coefficient of determination (r2) and probability level (p):

DRY MATTER (%) = 21,803 + 0,0053 * FINAL WEIGHT (kg)
r = 0,286; r^2 = 0,0818; p<0,0001

WATER (%) = 78,197 - 0,0053 * FINAL WEIGHT (kg)
r = -0,286; r^2 = 0,0818; p<0,0001

Rako (1970) has established that intramuscular fat could be worthy selection criterion for establishing cattle meat quality.

CONCLUSION

Our results show that investigated traits are correlated and that sire, year, month and season influence those traits. These facts we have to take into account when calculating phenotypic and genetic parameters for breeding animals. Also these findings have to be taken into consideration when choosing specific traits for AI bulls' selection. Considerable variation of MLD fat content among sires of the same breed suggests that this could be a matter of further research in the selection.

SAŽETAK

FENOTIPSKE KARAKTERISTIKE KEMIJSKOG SASTAVA M. LONGISSIMUS DORSI U SIMENTALSKIH BIKOVA U HRVATSKOJ

Simentalska pasmina je poznata kao dvonamjenska pasmina i veoma je raširena u Republici Hrvatskoj. Više od dvije trećine sveukupne populacije goveda u Hrvatskoj otpada na simentalsku pasminu. U ovom smo ispitivanju pozornost obratili na kemijske komponente (suhu tvar, vodu, bjelančevine, mast i pepeo) u musculus longissimus dorsi (MLD) i njegove fenotipske karakteristike. U pokus je bilo uključeno 710 mladih bikova podrijetlom od rasplodnih bikova odabranih za umjetnu oplodnju (UO), tijekom razdoblja od 13 godina.

Prosječan kemijski sastav MLD bio je sljedeći: suha

tvar 24,87±0,04%, voda 75,13±0,04%, bjelančevine 20,66±0,05%, mast (ekstrakt etera) 3,12±0,06% i pepeo 1,10±0,002%. Izračunali smo fenotipske korelacije između kemijskih komponenti te analizirali razne utjecaje za sve komponente. Svi izračuni su rađeni u SAS 8.0 (Sustav statističke analize) i Statistika 7.1. Fenotipske korelacije između suhe tvari i vode, bjelančevina, masti i pepela iznosile su–1,000, 0,159, 0,533 odnosno –0,164. Korelacije između vode i bjelančevina, masti i pepela bile su –0,159, -0,533 odnosno 0,164. Koeficijent korelacije između bjelančevina i masti bio je –0,750, između bjelančevina i pepela –0,026 a između masti i pepela –0,113. Svaka je korelacija bila značajna (P<0,01), uz iznimku korelacije između bjelančevina i pepela. Utjecaj godine, godišnjeg doba, mjeseca i bika na kemijski sastav MLD bio je značajan (P < 0,001).

Procjene fenotipske korelacije pokazuju da bi se ispitivane karakteristike mogle koristiti za selekciju bikova za UO.

Ključne riječi: *Simentalska goveda, meso, kemijski sastav, fenotipska korelacija*

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OCCURRENCE OF SELECTED TRACE ELEMENTS IN CATTLE MEAT

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SUMMARY

The occurrence of trace metals (Cu, Zn) was determined in cattle meat from the vicinity of a metallurgical plant. Copper and zinc concentrations in 62 samples of muscles and liver collected from (31) cows were quantified and compared with results in other countries. In our study

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