Certain influences on the histomorphological properties of muscle fibers in bulls of Simmental breed and crossbreeds with Montbeliarde breed

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SUMMARY

Minimal muscle fiber diameter, area and extent of each muscle fiber were measured with computer - aided method. Samples were taken 24 to 35 hours after death from the middle part of musculus longissimus dorsi after 7th rib and were studied in 31 bulls of Simmental (S) and cross - breed Simmental*Montbeliarde (S*M) bulls. Muscle fibers were determinated on the basis of succinat dehydrogenease activity to red - oxidative, and white - glycolitic muscle fibers. On the basis of myosin ATPase activity muscle fibers were determinated to type I and type II. There were differences among in estimated minimal diameter, area and extent of red, white, type I and type II muscle fibers. The place (3 of them) for analysis on the experimental sample had significant effect on the type II muscle fiber properties - for yet uncertain reason. Effects which influenced the properties of muscle fibers type I were not the same for red muscle fibers. The same problem was between muscle fibers type II and white muslce fibers.

INTRODUCTION

The composition of skeleton muscles and properties of muscle fibers in cattle are quite variable and depend on the breed, age and weight, sex, addition stimulants, fattening period in Oxen, musculature in bulls and the place of sampling of muslce in m.longissimus dorsi (MLD). Nevertheless, considerable intra and interindividual differences exist as well.

The mechanisms of postnatal growth of muscle fibers has not been explained yet. The recent aids like computers and various software have enabled the studies, which used to be time-exhausted and even inacurrate.

MATERIAL AND METHODS

In the research there were 31 bulls, 13 Simmental (S) bulls were from three different sires and 18 Simmental*Montbeliarde (S*M) crossbreeds were from two sires. 3.3 kg of mixture, maize silage and libitum and 0.5 to 1 kg of hay were daily fed to bulls. At slaughter the S bulls weighted 573.5 kg at average, and S*M crossbreeds 542.1 kg. From the right halves, a dissection was made into the more important parts, which were divided following the system of rough tissue division into separate tissue (meat, fat, bones and tendons).

Three to four cm thin slices of meat, cut after seventh rib from MLD were taken 24 to 35 hours after slaughter from S bulls and S*M crossbreeds. Slices of meat were labelled, wrapped into aluminium foil and stored in an ice-safe due to transport (3 hours).

In the laboratory a piece of meat (1cmx1cmx1cm), was cut from the middle slices of meat MLD. The so formed samples were sunk into liquid nitrogen (-196^{o}C) for 5 to 7 sec., wrapped into aluminium foil, labelled and put into deep freezer (-20^{o}C) until histochemical analysis.

When the samples were taken from the deep freezer they were carried to Cyro-cut (-20^{o}C). Four successive serial slices of 10 um were cut from the frozen sample.

SDHase activity in muscle fibers was shown by Padykuli method (1952, cit. by Kozarić, 1988), and ATPase was demonstrated by the modified calcium method by Padykuli and Herman (1955, cit. by Kozarić, 1988).

Coloured histochemical samples were photographed by a microscope while the muscle fiber properties were measured on photos (x210). On each sample three places for a histochemical activity were determined and photographed. Min.muscle fiber diameter, area and extent of each muscle fiber were measured with computer - aided method (Pernuš et al., 1986).

Three photos of each sample with mATPase activity (pH 9.4 fixative) and three photos with SDHase activity were used in a computer - aided analysis. Muscle fibers were determined on the basis of mATPase (pH 9.4 fixative) activity to type I and type II. On the basis of SDHase activity the muscle fibers were determined to red (R) and white (W). Due to used classification muscle fiber type I and type II were studied separately.

Data obtained for measurement of min. diameter, area and extent on the transverse section of muscle fibers for bulls of two mentioned breeds were statistically processed by LSMLMW (Harvey, 1985). The effect of breed (B), sire (S) within breed, place of sampling (P), weight at slaughter (W), interaction of breed*weight (B*W), meat % in the back (%mb), interaction of place on the sample*meat % in the back (P*%mb), fat % in the back (%ft), interaction of place on the sample*fat % in the back (P*%bt), fat % in a carcass (%tc) and meat % in a carcass half (%mc) at min. diameter of muscle fiber, area and extent on the transverse section of muscle fibers were determined by a statistical analysis.

RESULTS AND DISCUSSION

The analysis of variance showed that the min.diameter, area and extent on the transverse section of muscle fibers type I and type II were effected by the breed. S bulls had statistically significantly greater min.diameter, greater areas and extents on the transverse section of muscle fibers type I and type II compared to crossbreeds S*M.

In the literature no studies on muscle fiber in S*M crossbreeds have been reported. The effects of breed on average min. diameter of muscle fibers were studied in oxen of Charolais and Angus breed. Oxen of Charolais breed had statistically significantly thicker fibers of all three types compared to oxen to Angus breed (Johnston et al., 1975). Analysis of muscle fibers in MLD showed that Hereford bulls had widder tibers compared to Simmental, Bolgarian Brown and Holstein-Friesian breeds (Alexandrova, 1990).

Table 1: Analysis of variance for the min.diameter, area and extent on the transverse section of muscle fibers type I and type II

		Type I							Type II					
		Min.diam.		Area		Extent			Min.diam.		Area		Extent	
Variance source	d.f.	F	Sig.	F	Sig.	F	Sig.	d.f.	F	Sig.	F	Sig.	F	Sig.
B	1	4.23	*	9.20	**	8.34	*	1	5.70	*	4.99	*	13.96	**
P	2	1.47	NS	1.02	NS	0.79	NS	2	5.05	**	4.23	*	3.94	*
S(S)	2	9.06	***	4.67	**	11.79	**	2	53.76	***	46.61	***	70.96	***
S(S*M)	1	33.83	***	73.17	***	89.49	***	1	22.05	***	69.72	***	55.54	***
W-l.r.	1	19.69	***	44.61	***	49.96	***	1	2.02	***	30.82	***	43.33	***
B*W-l.r.	1	26.24	***	41.91	***	41.91	***	1	4.78	***	26.34	***	56.84	***
W-q.r.	1	0.00	NS	0.27	NS	1.34	NS	1	0.03	NS	2.73	NS	21.54	***
B*W-q.r.	1	0.34	NS	2.13	NS	6.44	*	1	0.17	NS	3.68	NS	13.55	***
%mb-l.r.	1	14.59	***	17.03	***	8.28	**	1	21.69	***	25.72	***	8.92	**
P*%mb-l.r.	2	0.08	NS	0.74	NS	0.06	NS	2	2.09	NS	2.08	NS	1.74	NS
%mb-q.r.	1	2.24	NS	0.11	NS	0.10	NS	1	15.33	NS	0.86	NS	0.00	NS
P*%mb-q.r.	2	0.05	NS	0.06	NS	1.07	NS	2	2.42	*	3.78	*	6.49	**
%fb-l.r.	1	1.41	NS	3.08	NS	1.01	NS	1	29.22	***	38.57	***	33.69	***
P*%fb-l.r.	2	0.62	NS	3.98	*	1.55	NS	2	5.41	***	7.73	***	4.20	*
%fb-q.r.	1	0.00	NS	0.11	NS	0.02	NS	1	0.07	NS	0.03	NS	0.03	NS
P*%fb-q.r.	2	1.00	NS	1.95	NS	2.12	NS	2	0.55	NS	1.12	NS	2.79	NS
%fc-l.r.	1	0.22	NS	2.07	NS	1.06	NS	1	12.07	**	6.98	**	29.66	***
%mc-l.r.	1	2.84	NS	0.13	NS	7.04	**	1	0.12	NS	1.79	NS	3.05	NS
Residue	1070							3220						

NS-P>0,05; *-P<0,05; **-P<0,01; ***-P<0,001;
l.r. - linear regression; q.r. - quadratic regression;

The place on the sample did not significantly influence the studied properties of muscle fibers type I, but it had a statistically significant effect on the studied properties of muscle fiber type II. Significant differences in min.diameter of muscle fibers type II among places on the sample can be explained by a later frowth potential of muscle fibers type II (Solomon et al., 1986). Muscle fibers might grow differently or less intensively in certain bundles.

Sires of S bulls and S*M crossbreeds significantly influenced the studied properties of muscle fibers type I and II. Weight at slaughter significantly influenced the studied properties of muscle fiber type I and type II. The similar conclusions are found in literature as well due to the fact that diameters of muscle fibers depend on increasing weight and age of the animal (May et al., 1977). Percentage of meat in back influenced statistically significantly the studied properties of muscle fibers type I and type II. Percentage of fat in a carcass statistically significantly influenced the studied properties of muscle fibers type II. The studied properties of muscle fibers of both types were significantly correlated with the meat % in the back.

Interaction of place on the sample*meat % in the back, fat % in the back, fat % in carcass and interaction of place on the sample*fat % in the back statistically significantly influenced the studied properties of muscle fibers type II.

The study has shown that the breed significantly influenced the studied properties of red and white muscle fibers. Properties of red and white muscle fibers were also influenced by the sires of S breed. Weight at slaughter, interaction breed*weight, interaction place on the sample*meat % in the back, interaction place on the sample*fat % in the back and fat % in the back had significant effect to the properties of red muscle fiber. Percentage of meat and fat in the back, fat and meat % in carcass half had significant effect on white muscle fiber properties.

The analysis of all four types of muscle fibers has shown that there are no perfect relations between both classification modes of fibers. The study of effects on the properties of four types of muscle fibers has pointed that effects, which influenced the studied properties of muscle fibers type I were not the same for red muscle fibers. The same problem was between type II and white muscle fibers.

In Table 2 the results of the analysis of variances of the studied properties of red and white muscle fibers are indicated.

Table 2: Analysis of variance of minimal diameter, area and extent on the transverse section of red and white muscle fibers

	Red							White						
		Min.diam.		Area		Extent			Min.diam.		Area		Extent	
Variance source	d.f.	F	Sig.	F	Sig.	F	Sig.	d.f.	F	Sig.	F	Sig.	F	Sig.
B	1	26.78	***	34.54	***	26.41	***	1	0.12	NS	0.08	NS	0.34	NS
P	2	2.26	NS	2.44	NS	1.76	NS	2	2.03	NS	0.03	NS	1.34	NS
S(S)	2	4.35	*	0.72	NS	0.96	NS	2	24.66	***	26.41	***	22.83	***
S(S*M)	1	10.43	**	25.08	***	20.61	***	1	52.57	***	86.56	***	81.96	***
W-l.r.	1	22.06	***	48.20	***	24.11	***	1	4.64	*	11.68	***	12.92	***
B*W-l.r.	1	13.35	***	27.22	***	5.37	*	1	1.15	NS	0.05	NS	0.18	NS
W-q.r.	1	4.00	*	0.29	NS	6.35	*	1	19.43	***	11.29	***	13.68	***
B*W-q.r.	1	0.39	NS	1.43	NS	0.52	NS	1	0.01	NS	1.92	NS	0.96	NS
%mb-l.r.	1	0.60	NS	0.37	NS	2.77	NS	1	10.71	**	12.58	***	24.08	***
P*%mb-l.r.	2	6.56	**	5.67	**	6.43	**	2	2.51	NS	3.21	*	3.71	*
%mb-q.r.	1	9.82	**	18.63	***	12.93	***	1	17.83	***	31.30	***	36.96	***
P*%mb-q.r.	2	1.14	NS	2.39	NS	1.79	NS	2	1.23	NS	0.78	NS	1.44	NS
%fb-l.r.	1	0.27	NS	0.01	NS	5.09	*	1	0.00	NS	0.21	NS	2.40	NS
P*%fb-l.r.	2	7.30	***	7.62	***	8.63	***	2	1.31	NS	1.51	NS	1.28	NS
%fb-q.r.	1	3.86	*	6.80	**	2.52	NS	1	63.68	***	76.65	***	80.66	***
P*%fb-q.r.	2	0.44	NS	0.59	NS	0.84	NS	2	1.11	NS	1.88	NS	2.09	NS
%tc-l.r.	1	1.10	NS	0.44	NS	0.56	NS	1	42.82	***	34.55	***	30.82	***
%mc-l.r.	1	2.19	NS	0.31	NS	1.26	NS	1	35.22	***	28.52	***	35.36	***
Residue	1386							1865						

NS-P>0,05; *-P<0,05; **-P<0,01; ***-P<0,001;
l.r. - linear regression; q.r. - quadratic regression;

CONCLUSIONS

On the basic of the study of min.diameter, area and extent on the transverse section of muscle fibers of a single type in 13 bulls from 3 sires and in 18 S*M crossbreed bulls from two sires it can be summarized that:

1. Simmental bulls had greater estimated min.diameter, area and extent of muscle fibers type I (50.38 um, 3078.60 um^2, 707.95 um) compared to S*M crossbreeds (47.28 um, 2751.45 um^2, 6565.71 um) and greater estimated min. diameter, area and extent of fibers type II (50.71 um, 3423.64 um^2, 784.90 um) compared to S*M crossbreeds (48.91 um, 3258.58 um^2, 740.50 um).
2. Simmental bulls had greater estimated min.diameter, area and extent of red muscle fibers (57.14 um, 3678.00 um^2, 791.39 um) compared to S*M crossbreeds (51.26 um, 3057.60 um^2, 706.55 um) and min.diameter of white muscle fibers (57.53 um), S*M crossbreeds (57.15 um). Crossbreed S*M bulls had greater estimated area and extent of white muscle fibers (4089.56 um^2, 852.09 um) compared to S bulls (4056.58 um^2, 842.80 um).
3. The place on the sample significantly influenced the studies properties of muscle fibers type II. Muscle fibers type I may stop growing quicklier while muscle fibers type II grown differently and more intensively even in higher weights.
4. The effects influencing the studied properties of muscle fibers type I were not the same for red muscle fibers. The same problem was between type II and white muscle fibers.

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