

Histochemical structure of longissimus and semitendinosus muscle and meat quality of the bulls with muscular hypertrophy.

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The aim of our investigations was to determine the muscle fiber types ratio and to determine meat properties of the bulls with muscular hypertrophy of the dairy breeds in Poland. The experiments were performed on m.longissimus dorsi and m.semitendinosus of 25 double muscled bulls and of 25 Black-and-White normal bulls. It was found that the longissimus dorsi and semitendinosus muscle of double muscled bulls had greater percentage of the fibers with higher succinic dehydrogenase and higher myoglobine peroxidase activity, and inversely, they had more content of the fibers with higher myofibrillar ATP-ase activity. Average diameters of the fibers in the double muscled bulls were smaller than in normal bulls. These data indicated that muscle hypertrophy is a result of increased proportion of the fibers with high glycolytic activity and decreased proportion of the fibers with high oxidative activity. Muscle hypertrophy seems to be rather related to the increasing of the fiber number than to an enlargement of muscle fiber diameter. Lower proportion of the fibers with high oxidative activity is associated with the lower total pigment and myoglobin contents and lighter colour of the meat. We didn't find any differences in the pH<sub>48</sub> value and the thermal drip was lower in the meat from double muscled bull.

Die histochemische Struktur des M.longissimus dorsi und M.semitendinosus und die Fleischqualität beim Rind mit der Muskelhypertrophie /Doppellender/.

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Das Ziel der Arbeit war die Bestimmung der Verhältnisse zwischen den verschiedenen enzymatisch aktivierten Muskelfasern, wie auch der Fleischqualität der in Polen gezüchteten Doppellenderbullen der Milchrassen. Die Untersuchungen wurden an den M.longissimus dorsi und M.semitendinosus von 25 Bullen mit Muskelhypertrophie und 25 Kontrollbullen des polnischen Schwarzbunten Niederungsviehs durchgeführt. In den beiden Muskeln der hypertrophischen Bullen wurde das Vorkommen der geringeren Fasermengen mit der höheren Succinodehydrogenase und Myoglobinperoxidaseaktivität und grössere Muskelfasermengen mit der hypertrophischen Bullen waren die Muskelfaserdiameter kleiner. Die Untersuchungen haben aufgewiesen, dass die Muskelhypertrophie mit der Steigung der Faserzahl mit der hohen glykolytischen Aktivität, wie auch mit der Senkung der Faserzahl mit der hohen oxydativen Aktivität verbunden ist und immer mehr mit der Steigung der Faserzahl als mit der Vergrößerung deren Diameter. Die geringere Fasermenge mit der hohen oxydativen Aktivität wurde durch geringeren Gesamtfarbstoff und Myoglobingehalt, sowie hellere Fleischfarbe begleitet. Der Kochverlust war geringer in dem Fleisch der Bullen mit Muskelhypertrophie.

## 4.11

Structure histochimique de musculus longissimus dorsi /m.l.d./ et de musculus semitendinosus /m.s./ ainsi que la qualité de la viande de bétail atteint de la hypertrophie musculaire /H.M./

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Le but du travail était de définir la proportion des fibres musculaires différenciées à l'égard de l'activité enzymatique et de déterminer la qualité de la viande des taureaux des races laiteux en Pologne qui se caractérisent par la hypertrophie musculaire. Les recherches sont effectuées avec le m.l.d. et m.s. des 25 taureaux démontrant la H.M. et des 25 taureaux de contrôle provenant de la race noir-blanc. On a constaté que les deux muscles des taureaux H.M. enferment l'inférieur nombre des fibres avec plus haute activité de la succinodéshydrogénase et de la myoglobine peroxydase et la majorité des fibres avec une plus haute activité d'ATP-ase myofibrillaire. Les diamètres des fibres musculaires étaient moins grands dans les deux muscles des taureaux HM. Les recherches ont démontré que la hypertrophie musculaire est liée avec l'augmentation de la qualité des fibres dont l'activité glycolytique est haute et avec la diminution du nombre de fibres dont l'activité oxydative est haute; quand même, plus avec l'augmentation du nombre de fibres qu'avec l'augmentation de leur diamètres. L'inférieur nombre de fibres à haute activité oxydative est accompagné de l'inférieure contenance totale en pigments et en myoglobine, de plus claire teinte de la viande. On n'a point constaté des différences en valeurs de  $pH_{48}$ . Le coulage libre d'eau fut abaissé dans la viande des taureaux H.M.

Гистохимическая структура m.longissimus dorsi и m. semitendinosus, а также качество мяса у рогатого скота с мышечной гипертрофией.

ДАНУТА КЛОСОВСКА, БОГУШ КЛОСОВСКИ И ЕЖИ РУЖИЧКА

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Целью работы было определение дифференцированных пропорций по отношению к энзиматической активности мышечных волокон, а также определение качества мяса бугаев молочных пород, выступающих на территории Польши и характеризующихся мышечной гипертрофией. Исследования были проведены на m.longissimus dorsi и m.semitendinosus 25 бугаев с мышечной гипертрофией и на 25 контрольных породы чёрно-белой. Констатируется, что в обеих гипертрофических мышцах бугаев появляются меньшие количества волокон с высшей активностью сукцинатного дегидрогеназы и пероксидазы миоглобина и большие количества волокон с более высокой активностью миофибрилярного АТФ-аза. Диаметры мышечных волокон были меньше в обеих мышцах гипертрофических бугаев. Исследования показали, что мышечная гипертрофия связана с увеличением количества волокон с высокой оксидативной активностью, а также больше с увеличением количества волокон, чем с увеличением их разреза. Меньшее количество волокон с высокой оксидативной активностью сопровождалось более низким содержанием общих пигментов и миоглобина, более светлым цветом мяса. Не констатируется разницы высоты окончательного pH. Термический экссудат был более низким в мясе бугаев с мышечной гипертрофией.



Histochemical structure of the longissimus and semitendinosus muscles and the meat quality of the cattle with muscular hypertrophy.

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Introduction

Considerable attention was devoted to histological structure of muscles of the cattle with muscular hypertrophy, double-muscled cattle and to their meat quality, particularly to the tenderness and palatability /Menissier, 1974/. Very little however has been done to investigate the relationship between chemical and physical properties of the muscles and their histochemical characteristics. The present study was designed to investigate the oxidative and glycolytic activities of the muscle fibers, the proportion of the differentiated muscle fibers, their size in longissimus dorsi and semitendinosus muscle in association with some meat quality of double-muscle bulls.

Material and Methods

The investigations were carried out on the m.longissimus dorsi /LD/ and m.semitendinosus /S/ of 25 double-muscled /DM/ bulls and of 18 normal bulls /N/. Samples for histological examinations were taken immediately after slaughter. One part of muscle samples was fixed in glutaraldehyde and sectioned on freezing microtome. Transverse sections /20 $\mu$ m/ were used for myoglobin peroxidase reaction /Morita et al. 1969/. The other part of muscle samples was frozen in isopentane which had been cooled in liquid nitrogen, and sectioned on cryostat. Transverse sections /10 $\mu$ m/ were incubated for succinic dehydrogenase activity /SDH/ and ATP-ase activity /Dubowitz et al. 1973/. Fibers size were estimated by measurement of the least diameter /Brooke, 1970/. The following fibers were differentiated: red fibers- including these with high and intermediate activity of SDH and of myoglobin peroxidase and showing a low and intermediate activity of myosin ATP-ase; white fibers- showing high activity of myosin ATP-ase and a low activity of SDH and myoglobin peroxidase. The fiber content was determined within 10 muscle bundles. Meat quality analysis was performed 48 h after slaughter. The following determinations were carried out: myoglobin and total pigment contents /Poel, 1948/, meat colour as dominant wavelength, saturation, lightness /Kortz et al. 1964/, colour stability in terms of percent of change in colour, water holding ability /Różycka and Michalski, 1978/, thermal drip losses /Walczak, 1959/ and ultimate pH by glass electrodes. The results were calculated by analysis of variance /Snedecor, 1956/.

Results and Discussion

Percentage of the fibers for both hypertrophied and normal bulls is presented in Fig. 1. As can be seen from data a significantly lower red fiber content was found in the DM bulls than in the normal ones. The percent of the red fibers differentiated by SDH and by myoglobin peroxidase activity was almost identical. Contrary to the results of Dubowitz and Pearce /1960/ according to which there exist a reciprocal relationship between oxidative and glycolytic enzymes activity in myofibers, we have not been found such consistence in the present study similarly as Hendricks et al. 1973. Much more white fibers were found by myosin ATP-ase than by myoglobin peroxidase and SDH activity differentiation. Thus the part of myofibers included into that of high oxidative activity was characterized also by high activity of glycolytic enzymes. Particularly it was marked in the semitendinosus muscle of DM bulls /Fig.1./. It should suggest that the muscles of DM bulls were more related with glycolytic metabolism than those of normal ones. Our results confirmed the observations of Ashmore and Robinson /1969/, Holmes and Ashmore /1970/, Hendricks et al. /1973/ that hypertrophied muscles of the cattle contain a lower percentage of red fibers and a higher percentage of white fibers than the normal ones. Moreover, both muscles of the DM bulls had lower average diameter of the muscle fibers. These differences were significant for all fibers except of the white fibers diameter of the longissimus dorsi muscle /Fig.2./. The results of the measurement of muscle fiber diameter in the DM cattle obtained by the others differ. Hendricks et al. /1973/, West /1974/ found similarly to our results a smaller red fiber diameter in the DM cattle but Holmes and

Fig. 1. Percentages of the red and white fibers differentiated by SDH, myoglobine peroxidase /MP/ and ATP-ase activity in musculus longissimus dorsi /LD/ and musculus semitendinosus /S/ of double-muscled /DM/ and normal bulls /N/

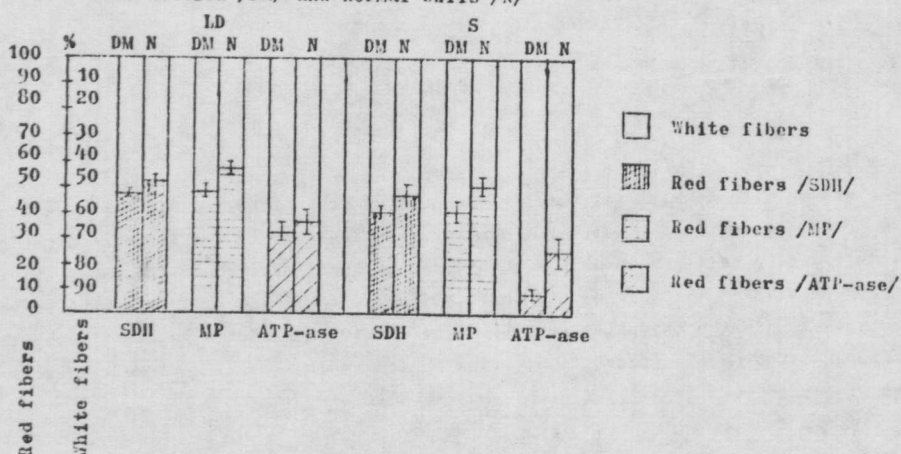
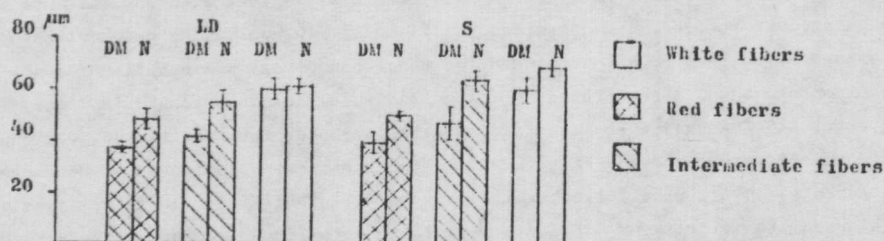


Fig. 2. Average diameter of the red, intermediate and white fibers in musculus longissimus dorsi /LD/ and musculus semitendinosus /S/ of double-muscled /DM/ and normal bulls /N/



Ashmore /1972/ found larger white fibers in the DM cattle. The histochemical characteristics of the muscles were associated with some meat properties /Table 1/. The DM bulls had in the muscles a smaller proportion of fibers with high oxidative activity and consequently they possessed a lower aerobic potential; their meat was characterized by the lower myoglobin and total pigment contents, by a lower dominant wavelength, lower saturation and by higher values of lightness. None differences were found in ultimate pH values. On the basis of the increasing percentage of the white fibers in the DM muscles we could hope to find some analogy with the muscles of the heavy muscled pigs in which there was also observed greater percent of the fibers with high glycolytic activity /Cooper et al. 1969; Dilley et al. 1970; Kłosowska, 1973/. The meat of heavy muscled pigs contained also less myoglobin and had lighter colour /Dilley et al. 1970/ and simultaneously showed lower colour stability, poorer water holding capacity, higher thermal drip losses /Janicki and Kortz, 1973/. Contrary to the poorer meat quality of the heavy muscled pigs the meat of the DM bulls showed some higher quality traits such as colour stability, water holding ability and lower thermal drip losses than in the normal bulls. These data contrary to suggestion of Ashmore et al. /1974/ could indicate that the meat quality of the DM bulls would be better in some traits than the normal ones. It is necessary to notice that the increasing muscularity in pigs of some breeds was related to the enlargement of the fibers diameter /Sair et al. 1970; Dilley et al. 1970; Kłosowska, 1973/ whereas the muscle hypertrophy in the cattle was rather associated, with the increase of the number of the muscle fibers with a lower diameter. Our results confirmed the conclusion of Staun /1963/ that the number and the diameter of muscle fibers could influence the meat quality. And meat with a large number of muscle fibers per unit of area is of higher quality than that with a small number of fibers. The higher content of the muscle fibers with high glycolytic activity in the DM bulls does not influence adversely the meat quality, probably due to the fine structure of the muscle with smaller fiber diameter.



Table 1. Mean values  $\bar{x}$  of physical and chemical properties of *m. longissimus dorsi* /LD/ and *m. semitendinosus* /S/ of double-muscled /DM/ and normal /N/ bulls.

Meat property		Double-muscled bulls		Normal bulls		Statistical significance of differences
		$\bar{x}$	s	$\bar{x}$	s	
Total pigment,	LD	259.88	± 57.02	402.94	± 58.42	xx
mg %	S	203.86	± 52.56	340.31	± 63.49	xx
Myoglobin,	LD	229.62	± 55.30	355.93	± 55.33	xx
mg %	S	185.00	± 53.44	305.41	± 72.77	xx
Colour						
Dominant	LD	597.50	± 2.59	600.4	± 3.33	xx
wavelength, nm	S	593.9	± 4.84	596.9	± 2.84	xx
Saturation, %	LD	32.80	± 9.21	36.16	± 7.58	xx
	S	28.20	± 4.84	36.08	± 8.36	xx
Lightness, %	LD	13.14	± 2.49	10.63	± 2.47	xx
	S	18.86	± 2.59	14.54	± 3.50	xx
Stability, % of	LD	21.94	± 10.09	24.53	± 6.80	xx
colour change	S	27.25	± 11.51	35.34	± 9.56	xx
Thermal drip,	LD	31.01	± 2.35	32.41	± 1.19	xx
%	S	32.65	± 1.95	34.08	± 1.36	xx
Water holding	LD	44.31	± 14.06	28.78	± 16.08	xx
ability, %	S	25.56	± 8.52	15.09	± 8.53	xx
pH ultimate	LD	5.52	± 0.09	5.55	± 0.08	NS
	S	5.51	± 0.09	5.55	± 0.08	NS

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