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HETEROGENEOUS COMPOSITION OF HISTOCHEMICAL FIBER TYPES IN THE DIFFERENT PARTS OF *M. LONGISSIMUS THORACIS* FROM MISHIMA (A JAPANESE NATIVE) STEERS.

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Background:

Mishima cattle breeding in the Mishima Island, Yamaguchi Prefecture in Japan, seem to have maintained the characteristics of the native breed and are expected to improve meat quality by crossing with other breeds. Histochemical properties of the skeletal muscle have not been examined yet.

Objectives:

Mammalian skeletal muscle is composed of fundamental 3 fiber types categorized with biochemical and physiological methods, namely slow-twitch oxidative, fast-twith oxidative glycolytic and fast-twitch glycolytic fibers (Peter et al., 1972). Using histochemical methods these fiber types are designated as Type β R(red), α R and α W(white) by Ashmore et al.(1972), respectively.

Although *M. longissimus thoracis (et lumborum)* contains about half myofibers as red (Type β R and α R) on the level of 11th thoracic vertebra in Japanese Black steers, this is a white muscle. Of 18 muscles observed by Iwamoto et al. (1991), the longissimus muscle contained Type α W fibers at the highest frequency in Japanese Black (50%), Japanese Brown (64%) and Holstein (69%) steers. However, regional difference of fiber type composition has been reported in cattle (Gotoh et al., 1994), pig (Iwamoto et al., 1989) and rabbit (Vigeneron et al., 1976) because of its unipennate structure.

In this study histochemical properties of the longissimus muscle were examined in fattened Mishima steers and compared with those of Japanese Black (Gotoh et al., 1994).

Methods:

Four Mishima steers had been fattened at Kumamoto Agriculutural Research Center. From left or right side of the carcass *M. longissimus thoracis (et lumborum)* was excised. Cross sectional materials about 2cm thickness were cut off at 3 parts on the level of 6th thoracic (LT I), 11th thoracic(LT II) and 5th lumber (LTIII) vertebra. Tissue were taken from the center of dorsal, central, ventral, medial and lateral subparts of each part. Serial frozen sections (8 μ m thick) were stained by histochemical reactions for myosin adenosin triphosphatase (ATPase) activities after acid (pH4.3) or alkaline (pH10.5) preincubation and reduced nicotinamide adenine dinucleotide dehydrogenase (NADH-DH) activity. Myofibers were divided into Type β R, α R and α W according to the nomenclature of Ashmore et al. (1972).

Results and discussions:

The Mishima steers had just gained 517.5kg of body weight at 35.8 months of age. The longissimus muscle weighed 6228g and occupied 1.20% of body weight.

Myofibers with a negative reaction for alkaline-ATPase activities and a positive for acid-ATPase were designated as Type β and those with the reverse reactions as Type α . The strongest NADH-DH activity was indicated by Type β and it was called as Type β R. Type α fibers were divided into Type α W showing the weakest NADH-DH activity and Type α R with the middle activity.

In each part regional differences of fiber type composition were not observed clearly because of its marked variation among the individual steers. On the combined data at each part, regional differences of fiber type composition were recognized (Table 1). The composition (β R37%, α R17%, α W46%) did not show any differences between LT I and LTIII but another composition (β R26%, α R15%, α W59%) was observed at LT II . Type β R fibers occurred at significantly smaller percentage and Type α W at larger in LT II than the other parts ($p<0.05$).

With the combined data of each part the largest diameter was indicated by Type α W fibers (55-65 μ m), the second by Type β R(51-56 μ m) and the smallest by Type α R (47-49 μ m) (Table 2). Any significant differences of the fiber diameter could not be recognized among parts or subparts.

At LT II the lomgissimus muscle of Japanense Black steers contains 31-34% of myofibers as Type β R, Japanese Brown 18% and Holstein 16% (Iwamoto et al., 1991; Gotoh et al., 1994). However, because of its larger relative size the percentage area of Type β R fibers (24%) in Mishima steers was the same as that in the Black showing the largest percentage in number (34%) (Gotoh et al., 1994). Although fiber size did not differ among the types in Mishima steers, in the other breeds Type β R fibers always show the smallest diameter of all types (Iwamoto et al., 1991; Gotoh et al., 1994). Large relative size of Type β R fibers was reported also in a wild pig by Solomon and West (1985). Skeleton muscle has developed much Type α W fibers of large size during animal domestication (Ashmore et al., 1972).

Conclusions:

From the result of relative large size of Type β R fibers, it was suggested that Mishima cattle have maintained some characteristics of the native breed.

Pertinent literature:

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Table 1. Percentage distribution of histochemical fiber types on the level of the 6th thoracic (LT I),11th thoracic (LT II) and 5th lumber (LT III)vertebrain the longissimus muscle.

Parts and Subparts	Percentage distribution Type β R	Type α R	Type α W
LT I			
Dorsal	45.7±6.9 $^{a\,b}$	20.4±5.5 ^{a}	33.9±7.7 ^{a}
Central	32.6±4.5 $^{a\,b}$	16.6±4.3 ^{a}	50.8±4.9 ^{a}
Ventral	36.9±4.4 $^{a\,b}$	16.4±3.5 ^{a}	46.8±2.0 ^{a}
Medial	31.4±1.3 ^{a}	16.0±0.4 ^{a}	52.6±1.4 ^{a}
Lateral	38.9±1.8 ^{b}	15.4±1.9 ^{a}	45.7±3.6 ^{a}
Combined	37.1±0.9 ^{x}	17.0±1.5 ^{x}	46.0±0.7 ^{x}
LT II			
Dorsal	23.8±2.7 ^{a}	11.1±2.2 ^{a}	65.1±4.9 ^{a}
Central	25.3±2.4 ^{a}	20.6±3.2 ^{a}	54.2±3.3 ^{a}
Ventral	28.7±2.7 ^{a}	16.8±2.8 ^{a}	54.5±4.6 ^{a}
Medial	25.7±2.8 ^{a}	12.2±2.1 ^{a}	62.1±3.7 ^{a}
Lateral	25.7±3.1 ^{a}	14.3±1.7 ^{a}	60.0±3.9 ^{a}
Combined	25.8±2.1 ^{y}	15.0±1.4 ^{x}	59.2±3.1 ^{y}
LT III			
Dorsal	41.1±7.5 ^{a}	17.6±3.3 $^{a\,b}$	41.3±4.5 ^{a}
Central	34.3±4.2 ^{a}	19.2±1.4 $^{a\,b}$	46.4±3.6 ^{a}
Ventral	38.6±7.0 ^{a}	14.5±3.1 $^{a\,b}$	46.9±5.0 ^{a}
Medial	26.6±5.2 ^{a}	17.1±3.5 $^{a\,b}$	46.6±2.1 ^{a}
Lateral	36.0±1.3 ^{a}	14.9±0.9 $^{a\,b}$	49.1±1.2 ^{a}
Combined	37.3±3.8 ^{x}	16.7±1.2 ^{x}	46.1±2.7 ^{x}

Means±standard errors. n = 4.

$^{a\,b}$ Means with same superscript do not significantaly differ between the subparts of each part at 5% level.

$^{x\,y}$ Means with same superscript do not significantaly differ between the parts at 5% level.

Table 2. Fiber diameter of each type in every subpart and part of the longissimus muscle.

Parts and Subparts	Fiber diameter (μ m) Type β R	Type α R	Type α W
LT I			
Dorsal	52.0±2.6 $^{\cdot}$	45.0±1.1 $^{\cdot}$	51.7±3.0 $^{\cdot}$
Central	51.5±3.1 $^{\cdot}$	47.1±3.8 $^{\cdot}$	57.6±5.0 $^{\cdot}$
Ventral	52.9±1.4 $^{\cdot}$	46.1±1.9 $^{\cdot}$	56.9±2.5 $^{\cdot}$
Medial	54.8±1.0 $^{\cdot}$	49.1±1.6 $^{\cdot}$	55.4±1.9 $^{\cdot}$
Lateral	54.7±2.9 $^{\cdot}$	46.5±2.6 $^{\cdot}$	53.0±4.4 $^{\cdot}$
Combined	53.2±1.6 ^{x}	46.7±1.9 ^{x}	54.9±2.9 ^{x}
LT II			
Dorsal	54.5±2.3 $^{\cdot}$	50.2±2.8 $^{\cdot}$	56.5±4.2 $^{\cdot}$
Central	48.2±2.5 $^{\cdot}$	47.0±2.2 $^{\cdot}$	56.9±4.9 $^{\cdot}$
Ventral	46.9±3.2 $^{\cdot}$	43.5±2.6 $^{\cdot}$	51.2±3.8 $^{\cdot}$
Medial	55.8±2.7 $^{\cdot}$	51.3±2.9 $^{\cdot}$	57.9±4.4 $^{\cdot}$
Lateral	48.6±4.0 $^{\cdot}$	44.3±2.7 $^{\cdot}$	53.3±4.1 $^{\cdot}$
Combined	50.8±2.6 ^{x}	47.2±2.3 ^{x}	59.2±3.1 ^{x}
LT III			
Dorsal	59.0±6.9 $^{\cdot}$	47.9±1.6 $^{\cdot}$	61.1±3.8 $^{\cdot}$
Central	56.5±1.2 $^{\cdot}$	50.8±3.7 $^{\cdot}$	64.4±4.4 $^{\cdot}$
Ventral	57.7±4.3 $^{\cdot}$	45.8±2.6 $^{\cdot}$	66.4±4.8 $^{\cdot}$
Medial	55.0±4.2 $^{\cdot}$	52.9±2.7 $^{\cdot}$	69.3±2.3 $^{\cdot}$
Lateral	50.8±2.0 $^{\cdot}$	47.8±0.9 $^{\cdot}$	64.8±4.3 $^{\cdot}$
Combined	55.8±1.6 ^{x}	49.0±1.1 ^{x}	65.2±3.2 ^{x}

Means±standard errors. n = 4.
Superscripts are the same as in Table 1.