Some Observations on the Giant Fibers Distribution in Bovine Muscles

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Giant muscle fibers were first observed in pig (Cassens et al, 1969; Dutson et al, 1978; Hendricks et al, 1971; Linke, 1972) and more recently in ox and sheep (Schmitt, and Dumont, 1979). The functional role of them is still obscure. In this paper evidence is presented on factors which influence the distribution of giant fibers in bovine muscles during preservation.

Materials and Methods

The study was conducted in 17 Friesian stears. One hour after the animals were killed, samples from Longisimus Dorsi and Trapezius muscles were taken for histologic examination. The muscles, then, preserved for six days in +1°C and +14°C. During preservation samples for histologic examination were also taken 5, 29, 100 and 150 hours post mortem. The samples were routinely fixed in 10% formalin, embedded in paraffin wax, sectioned and stained with H&E. In each section the giant fibers were observed and their number in a one square centimeter was counted. Measurements of pH also took place in 3g muscle tissue from all samples. For this, muscle tissue was homogenized in 30ml neutralized water with 0.1N NaOH.

For each group of measuremens which took place on a certain time post-mortem, the mean value, standard error and standard deviation were calculated. To all groups of measurements factorial analysis of variance was applied for three levels; that is for two muscles, two temperatures and five repetitions. Differences between repetitions were also established by applying one way analysis of variance. If the F value showed statistically significant differences, the Duncan-Kramer test was used.

Results

Giant fibers were observed mainly in the boundaries of muscle bundles. They were round in shape with an unusual diameter length about double of that of neighbouring fibers. With H&E were stained paler than normal fibers. Sometimes darker and in any case different from normal fibers.

The mean ± standard error of counting giant fibers during muscle preservation, appear according to muscle, preservation temperature and time in Table I.

Table I

Mean values ± standard error of muscle giant fibers counting during preservation of meat

Muscles \ Hours post mortem / T°	1	5	29	100	150
Longi-simus	+ 1°C	7.12±89	24.67 ± 9.58	8.85± 7.65	25.41± 2.94	19.39±10.19
	+14°C	7.12±89	14.77 ±10.95	16.07± 8.85	27.93±10.84	19.86± 8.93
Tra-pezius	+ 1°C	6.00±13	33.69± 3.78	35.81±11.33	41.39±11.37	42.31±14.31
	+14°C	6.00±13	53.54±12.99	25.80±10.25	36.44± 9.18	20.08±10.95

In Table II factorial analysis of variance for the fiber counts is shown. From this table it is evident that the number of giant fibers depends on the factors muscle, and time of preservation ($p < 0.01$). This influence is demonstrated in the tables of one way analysis of variance (Tables III, IV, V, VI) which are referred to the counting of giant fibers at different times post- mortem, for each muscle and preservation temperature. Statistically significant differences appear only in Trapezius muscle for both preservation temperatures. The Duncan - Kramer test results shown in the same tables demonstrate that the differences are statistically significant mainly between pre- and post-rigor counting. The rest of the factors examined as well as all probable combinations of these factors do not influence the number of giant fibers.

Table II

Table of factorial analysis of variance for the changes in the number of muscle giant fibers during preservation of meat

Source of Variation	Degrees of freedom	Mean Squares	F Value	Statistical Significance
Blocks	16	5395.99997	6.714	$p < 0.01$
Muscles	1	14557.91336	18.115	$p < 0.01$
Temperatures	1	137.28706	0.170	N.S.
Time	4	7918.94173	9.853	$p < 0.01$
Muscle X Temperatures	1	148.85735	0.185	N.S.
Temperatures X Time	4	439.34314	0.546	N.S.
Muscle X Time	4	1744.31255	2.170	N.S.
Muscle X T° X Time	4	1680.11908	2.090	N.S.
Error	304	803.63471		
Total	339			

Table III

Table of one way analysis of variance for the changes in the number of muscle giant fibers in Longisimus dorsi muscle during six days preservation in +1°C

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Treatments	4	5087.1077	1271.7769	1.39
Error	80	72886.2932	911.0786	
Total	84	77973.4010		N.S.

Table IV

Table of one way analysis of variance for the changes in the number of muscle giant fibers in Longisimus dorsi muscle during six days preservastion in +14°C

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Values
Treatments	4	3926.8237	981.7059	1.08
Error	80	77248.1171	903.1014	
Total	84	76174.9408		N.S.

Table V

Table of one way analysis of variance and Duncan-Kramer test for the changes in the number of muscle giant fibers in Trapezius muscle during six days preservation in +1°C

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Values
Treatments	4	14215.9757	3553.9939	2.76
Error	80	102685.3398	1283.5667	
Total	84	116901.3155		$p < 0.05$

1	2	3	4	5
6.00	35.69	35.81	41.39	42.31

Table VI
Table of one way analysis of variance (and Duncan-Kramer test) for the changes in the number of muscle giant fibers in Trapezius muscle during six days preservation in +14°C

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Values
Treatments	4	21727.5407	5431.8851	5.34
Error	80	81365.9264	1017.0740	
Total	84	103093.4671		p < 0.001

1	5	3	4	2
6.00	20.08	25.80	36.64	53.54

Discussion

The main observation which resulted from counting the giant fibers is that their number depends on muscle and time of preservation. The number of giant fibers does not change significantly during preservation in Longisimus dorsi muscle, while the opposite is the case in Trapezius muscle. In this muscle a statistically significant increase in the number of giant fibers was demonstrated between pre- and post-rigor counting. This difference was shown with factorial analysis of variance where a significant influence on the number of giant fibers was evident as being due to muscle and time of preservation.

Additional evidence is shown by the one way analysis of variance during preservation for the two muscles regardless of temperature of preservation. There is no significant F value for Longisimus dorsi while the opposite is the case for pre-rigor counting for Trapezius muscle (Tables VII, VIII). Also in Table IX is shown the one way analysis of variance for giant fiber counts during preservation of meat, regardless of muscle and temperature of preservation.

Table VII
Table of one way analysis of variance for counts for giant fibers, during preservation of Longisimus dorsi muscle, regardless of temperature of preservation

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Values
Treatments	4	5550.0295	1387.5073	
Error	152	138154.7731	908.9129	1.53
Total	156	143704.8027	921.1846	N.S.

Table VIII
Table of one way analysis of variance for counts of giant fibers, during preservation of Trapezius muscle, regardless of temperature of preservation

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Values
Treatments	4	16676.5134	4169.1286	3.32
Error	149	187043.0789	1255.3226	
Total	153	203719.5923	1331.5006	p < 0.01

1	5	3	4	2
6.00	29.39	30.81	38.85	41.79

Table IX

Table of one way analysis of variance for counts of giant fibers, during preservation of meat, regardless of muscle and temperature of preservation

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Values
Treatments	4	19121.2614	4780.3153	4.21
Error	307	348921.1679	1136.5510	
Total	301	368042.4294	1183.4163	$p < 0.01$

1	3	5	2	4
6.56	21.63	24.41	31.36	32.51

To suggest that the number of giant muscle fibers changes during preservation of muscle in Trapezius muscle, would be unrealistic. However, it could very cautiously be suggested that giant muscle fibers possess a biochemical-physiological characteristic which manifests itself with the special morphology of these fibers under post-mortem conditions.

This point of view is supported by the particular histochemical characteristics of the giant fibers (Cassens et al, 1969). Also from the fact that the special morphology and histochemical profile rather than size determine the muscle fibers as giant. In any case the round shape of the fibers resembles swollen fibers which do not lose their water holding capacity.

In relation to this one could possibly point out to significantly higher pH values which was demonstrated to exist in Trapezius muscle. Regardless of time and temperature of preservation, mean pH values were 5.99 for Trapezius and 5.82 for Longisimus dorsi muscle ($p < 0.01$). The mean counts of giant fibers were respectively 33.03 and 18.23 ($p < 0.01$). However, correlation coefficient value between pH measurement and giant fiber counts did not confirm the aforementioned piece of information ($r = 0.04$, N.S.).

References

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