ANSC/FSTC 607
Physiology and Biochemistry of Muscle as a Food
IONIC STRENGTH AND THE RESOLUTION OF RIGOR

I. Ionic strength and the resolution of rigor

A. The aging index

1. Increasing salt concentration (ionic strength) reduces the activity of the actomyosin ATPase.

2. Myofibrils from aged muscle are more sensitive to ionic strength than are myofibrils from fresh muscle.

3. Implies that, during aging, the normal increase in ionic strength causes dissociation of myofibrils → loss of A•M ATPase activity.

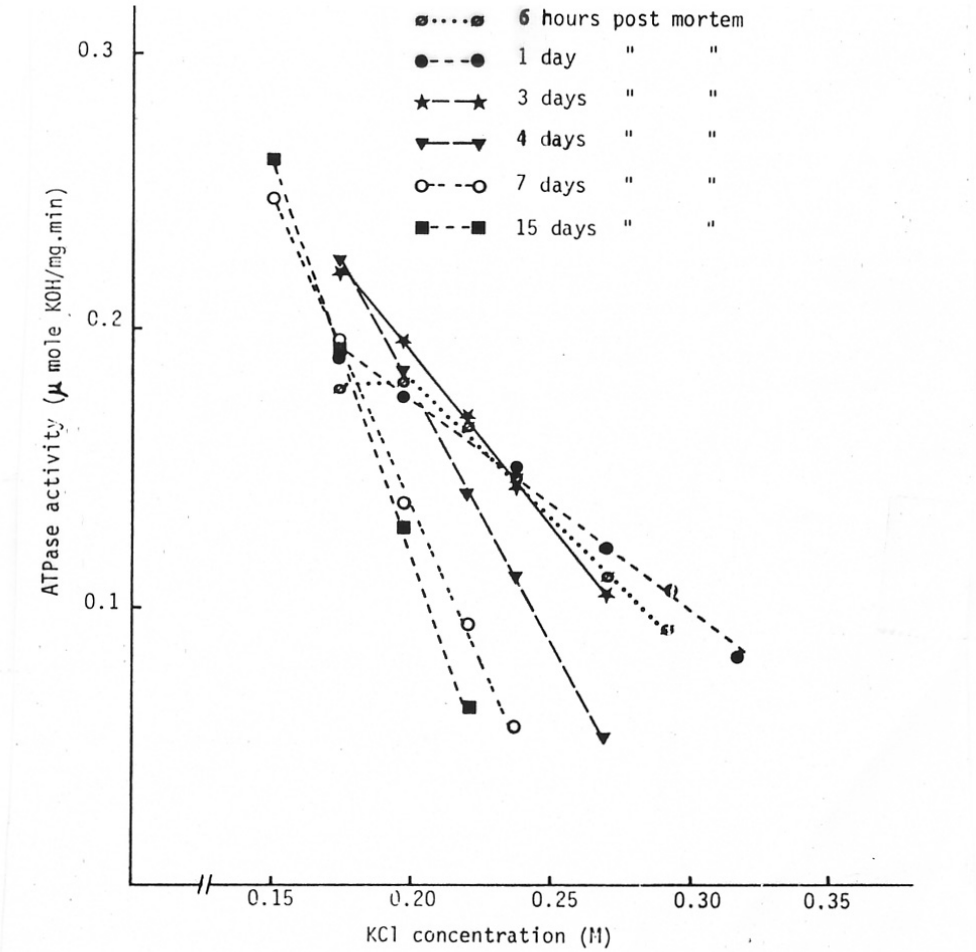


Fig. 1. Effect of conditioning of beef *Longissimus dorsi* muscle on Mg–Ca-enhanced ATPase activity and its sensitivity to ionic strength. The slope value of the straight line graph quantifies the ATPase sensitivity to ionic strength and represents the Biochemical Index of Myofibrillar Ageing (BIMA).

B. Ionic strength $I = \frac{1}{2} \Sigma c_i z_I$

Where one-half because both cations and anions are included;

c_i is the molar concentration of ion i

z_i is the charge number of the ion

Σ is the sum of all ions in the solution

For 0.3 M KCl, $I = \frac{1}{2} \times (0.3 \times (+1)^2 + (0.3 \times (-1)^2 = \frac{1}{2} \times (0.3 + 0.3) = 0.3$

For monovalent cations and ions (KCl, NaCl), ionic strength equals molarity of the solution.

II. Effects of ionic strength on myofibrillar solubilization

A. Incubating myofibrils were extracted from fresh muscle and incubated in 0.1 to 0.3 M KCl

B. Remaining myofibrils were pelleted by centrifugation.

C. Proteins that had solubilized were separated by polyacrylamide gel electrophoresis.

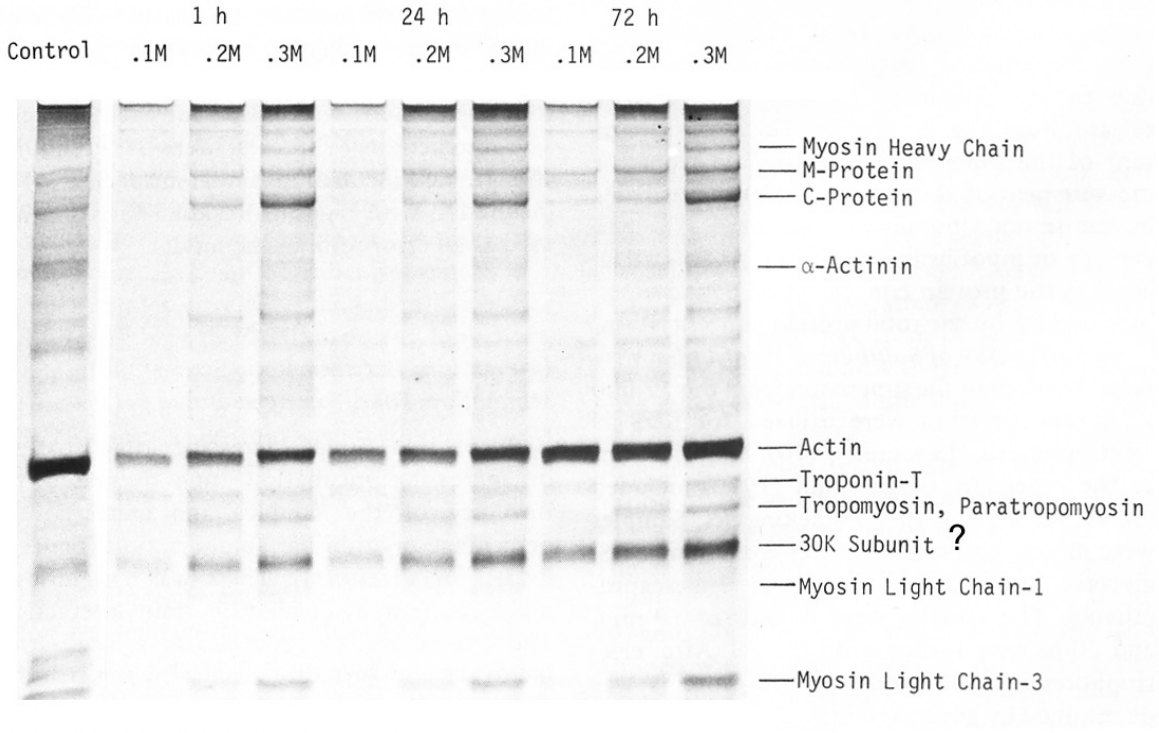
1. Many myofibrillar proteins were solubilized.

a. Myosin heavy chain

b. Actin

c. C-protein

d. M-protein

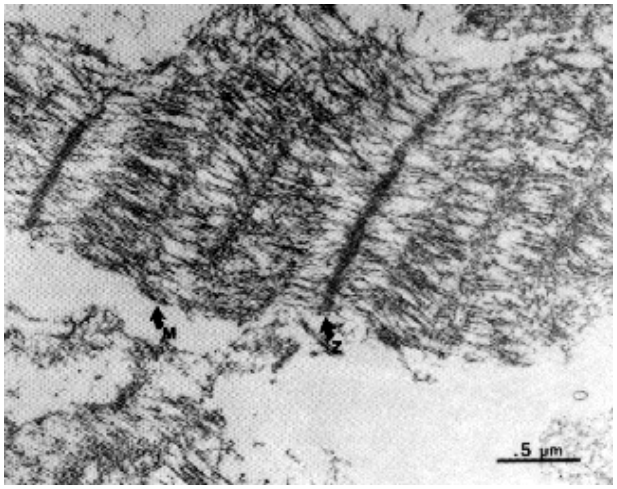


Polyacrylamide gel electrophoresis of proteins solubilized from myofibrils after incubation at different ionic strengths for 1, 24, or 72 h.

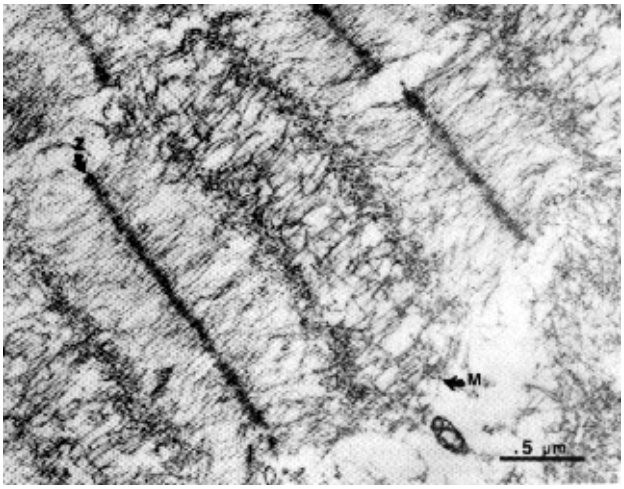
D. Interaction between trypsin and ionic strength

1. Trypsin hydrolyzed the Z-disc.

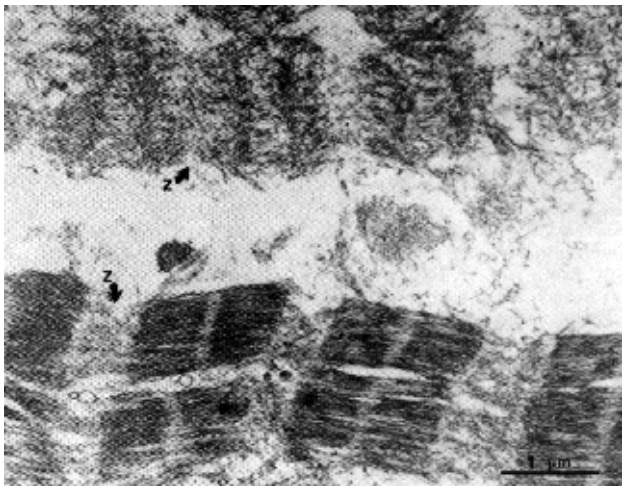
2 Trypsin plus 0.3 M KCl caused complete dissolution of myofibrils.



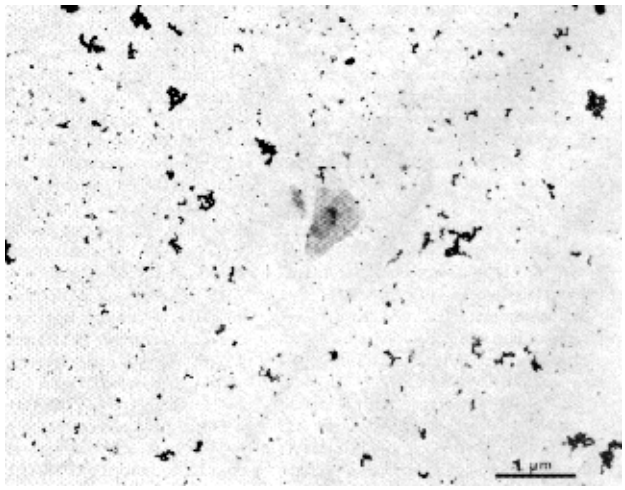
Longissimus muscle myofibrils incubated for 24 h with 0.1 M KCl.



Longissimus muscle myofibrils incubated for 24 h with 0.3 M KCl.



Longissimus muscle myofibrils incubated for 24 h with 0.1 M KCl following a 10-min preincubation with trypsin.



Longissimus muscle myofibrils incubated for 24 h with 0.3 M KCl following a 10-min preincubation with trypsin.

III. Infusing lamb carcasses with $CaCl_2$ or NaCl

A. Koohmaraie et al. (1989) injected lambs carcasses immediately postmortem with 0.1 M $CaCl_2$ or 0.4 M KCl (same ionic strength).

For 0.4 M KCl

$$I = \tfrac{1}{2} \times (0.4 \times (+1)^2 + (0.4 \times (-1)^2 = \tfrac{1}{2} \times (0.4 + 0.4) = \mathbf{0.4}$$

For 0.1 M $CaCl_2$

$$I = \tfrac{1}{2} \times (0.1) \times (+2)^2 + (0.1 \times 2 \times (-1)^2 = \tfrac{1}{2} \times (0.4 + 0.4) = \mathbf{0.4}$$

B. Shear force values

1. Shear force values plummeted for $CaCl_2$-injected lamb carcasses.

2. Rate of decline with NaCl infusion was *much* slower than was seen with $CaCl_2$ infusion.

3. Ultimate shear force was the same with NaCl and $CaCl_2$ infusion.

4. Calcium-dependent proteases work in combination with increasing postmortem ionic strength to increase muscle tenderness.