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Effect of deuterium oxide on X-ray diffraction pattern in glycerinated skeletal muscle fibers by a CCD X-ray detector

Takakazu KOBAYASHI[1], Wataru KATOH[1], Hidehiro TANAKA[2], Yasunori TAKEZAWA[3], Yasunobu SUGIMOTO[3], Kanji OHSHIMA[3] and Katsuzo WAKABAYASHI[3]
[1]Department of Electronic Engineering, Shibaura Institute of Technology, Minato-ku, Tokyo 108-8548
[2]Department of Physiology, Teikyo Heisei Junior College, Ichihara, Chiba 290-0158
[3]Department of Biophysical Engineering, Graduate School of Engineering Science, Osaka University, Toyonaka, Osaka 560-8531

Introduction

Muscle contraction results from cyclic formation and breaking of cross bridges between myosin head and actin binding site. Energy for contraction is supplied by ATP hydrolysis. Since molecular weight of deuterium oxide D_2O is larger than that of H_2O, binding force and characteristics of reaction to other chemicals are different. D_2O increases force and stiffness by about 20% with slow rising phase, and decreases ATPase activity by 40-50% [1][2]. To obtain information about structure change, the effect of substituting D_2O for H_2O studied by X-ray diffraction.

Materials and Methods

The rabbit glycerinated muscle fibers were mounted isometrically into the experimental chamber at 2.4 um of sarcomere length, and set to monochromatized X-ray beam path of wavelength 0.155nm from beam line 15A of synchrotron radiation. The two dimensional diffraction patterns from relaxed, rigor and Ca^{2+} activated fibers in D_2O were recorded by the CCD X-ray detector with force developments, and compared to those in H_2O. All experiments were made at room temperature.

Results

Figure 1. shows the diffraction patterns from relaxed muscle fibers in H_2O and D_2O. In relaxed muscle fibers, diffraction pattern in D_2O is much clearer than that in H_2O. Especially myosin layer lines appeared remarkably. These phenomenon occured when sequence of H_2O and D_2O is changed. Figure 2. shows intensity profiles of 1,0, 1,1 equatorial reflection in (A) and 143, 215 meridional refrection in B from relaxed in H_2O, D_2O and contracting muscle fibers in D_2O. 1,0 intensity change in D_2O increased, but 1,1 changed little. Both 143 and 215 intensity changes in D_2O increased more than 2 times. Remarkable differences are not seen between rigor or contracting fibers in H_2O and D_2O. These results suggest that helical regularity of myosin head of relaxed muscle fibers in D_2O increases more than that in H_2O. It might be related that in D_2O fraction of myosin head of M.ADP.Pi state increase.

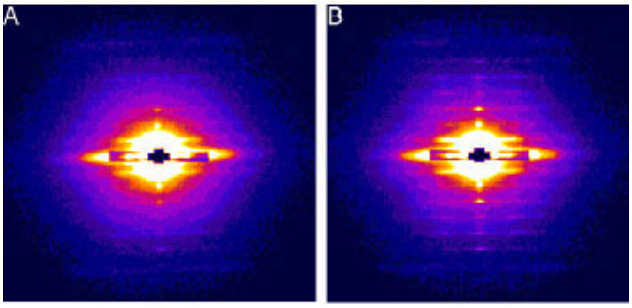

Figure 1. Diffraction patterns of H_2O (A) and D_2O (B) from relaxed muscle fibers.

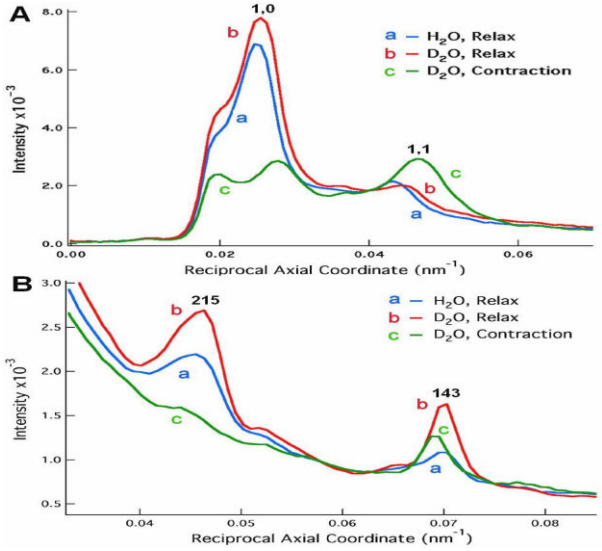

Figure 2. Intensity profiles of 1,0, 1,1 equatorial (A) and 143, 215 meridional refrection (B)

References

[1]S.Chaen et al.,Biochim. Biophys.Acta 1506 (2001)
[2]T.Kobayashi et al., Biochim. Biophys. Acta 1659 (2004)

*kobataka@sic.shibaura-it.ac.jp.