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Analysis of Titin in Red and White Muscles: Crucial Role on Muscle Contractions Using a Fish Model.

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Abstract

Several studies have compared molecular components between red and white skeletal muscles in mammals. However, mammalian skeletal muscles are composed of mixed types of muscle fibers. In the current study, we analyzed and compared the distributions of titin, lipid, phosphate ions, and fatty acid levels in red and white muscles using a fish model (*Tilapia*), which is rich in red and white muscles, and these are well separated. Oil-red O staining showed that red muscle had more-abundant lipids than did white muscle. A time-of-flight secondary-ion mass spectrometric (TOF-SIMS) analysis revealed that red muscle possessed high levels of palmitic acid and oleic acid, but white muscle contained more phosphate ions. Moreover, elastica-van Gieson (EVG) and Mito-Tracker green FM staining showed that collagen and elastic fibers were highly, respectively, distributed in connective tissues and mitochondria in red muscle. An electron micrographic analysis indicated that red muscle had a relatively higher number of mitochondria and longer sarcomere lengths and Z-line widths, while myofibril diameters were thicker in white muscle. Myofibrillar proteins separated by SDS-PAGE showed that the major giant protein, titin, was highly expressed in white muscle than in red muscle. Furthermore, ratios of titin to myosin heavy chain (MHC) (titin/MHC) were about 1.3 times higher in white muscle than red muscle. We postulated that white muscle is fit for short and strong contractile performance due to high levels of titin and condensed sarcomeres, whereas red muscle is fit for low intensity and long-lasting activity due to high levels of lipids and mitochondria and long sarcomeres.

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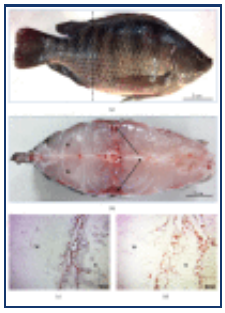
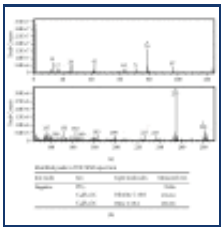
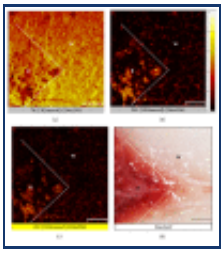
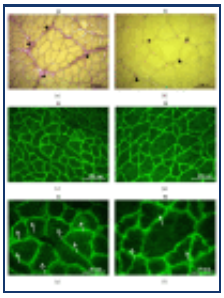
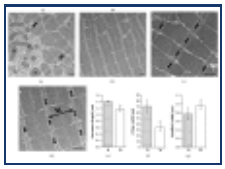
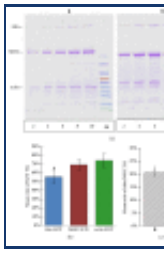

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