

食品成分によって抗疲労性筋線維を増やせるか

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Possible Contribution of Dietary Functional Food Ingredients to Fatigue-Resistant Myofiber Generation

by

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ABSTRACT

Proportions of muscle fiber types are responsible for a variety of properties of skeletal muscle, including contractile, metabolic, and sensory (differential tasting-component contents and fat deposition). Therefore mechanisms that regulate these properties, and their manipulation are hot targets of research for human sports and health sciences and animal production.

We recently found that resident myogenic stem satellite cells secrete semaphorin 3A (Sema3A) protein which exclusively impacts the formation of fatigue-resistant fibers (also called slow-twitch fibers) through a cell-membrane receptor (neuropilin2-plexinA3 complex) → myogenin/MEF2D/HDAC7 → slow-myosin signaling pathway 5). Here we report that an 8-week intake of chlorogenic-acid rich materials (APP; polyphenol mixture prepared from unripened apples) in the diet, may stimulate the Sema3A-dependent pathway concerned. Results demonstrated improvement of lower hind-limb muscle endurance based on increased proportions of fatigue-resistant

myofibers (types IIa and I) by the 0.5% APP-feeding to young-adult rats. There was no significant difference in the animal body-phenotypes or locomotor activity shown as total moving distance in light and dark periods. The result indicates that the shift in myosin heavy chain (MyHC) isoforms from fast-to-slow did not include a bias due to greater exercise behavior by the treated rats. Notably, a subsequent *in vitro* study showed that supplementation of APP (500 ng/ml) or the major component chlorogenic acid (10 ng/ml) also up-regulated the expression of slow MyHC and the up-stream signaling molecules, myogenin and MEF2D, in primary cultures of differentiating myoblasts. Other major polyphenols found in APP (procyanidin B1, B2, phloridzin, and catechin) in a range of 10-1000 ng/ml did not induce these effects.

Therefore, the present study highlights a possible contribution of dietary chlorogenic acid intake to antagonizing the Sema3A-signaling pathway responsible for fatigue-resistant fiber formation. The finding may help in developing a novel strategy for application in human sports and age-related health sciences.

要 旨

骨格筋の疲労耐性に関わる抗疲労性筋線維（遅筋型筋線維）の形成を食品成分によって亢進できるかどうか調べた。筋幹細胞である衛星細胞の初代培養系に食事性ポリフェノールであるクロロゲン酸を添加すると（終濃度 10 ng/ml）、抗疲労性筋線維の形成を誘導する新奇シグナル軸（Sema3A リガンド → 細胞膜受容体 neuropilin2-plexinA3 複合体 → 転写制御因子 myogenin-MEF2D → 抗疲労性 myosin）が活性化した。また、クロロゲン酸を主成分とするポリフェノール混合物を成熟ラットに 8 週間給餌すると（添加濃度 0.5%）、後肢下腿部筋の myosin アイソフォーム組成が抗疲労性方向へシフトし筋持久力が向上することが確認された。これらの結果より、クロロゲン酸が Sema3A 受容体のアゴニストとして抗疲労性筋線維の形成を促進すると考えられた。高齢者やスポーツ競技者などの筋疲労耐性向上への食品機能的貢献が期待される。