Acute vs. Chronic Citrulline Malate Supplementation on Muscle Fatigue

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ABSTRACT

Citrulline malate (CM) is a commonly sold over the counter ergogenic aid that has been gaining popularity due to its proposed ability to aid in reducing fatigue by increasing blood flow (1). Citrulline malate is composed generally in the ratio of 2:1 of citrulline, a nonessential amino acid, and malate, a Krebs cycle intermediate, respectively (2, 3). A majority of studies have suggested consuming citrulline and malate together with the above ratios increases the effectiveness because of the combined ability to enhance oxidative energy turnover, improve acid base balance, and lower energy cost for muscular force production (4, 5). The exact mechanism of how CM alleviates fatigue is not understood. One proposed theory is that CM is able to facilitate the clearance of ammonia, an amino compound that contributes to the urea cycle. Additionally CM is thought to increase nitric oxide concentrations through the nitric oxide synthase-dependent pathway by converting L-citrulline into L-arginine via the intestinal renal axis of the kidneys (3, 6). Once the conversion occurs, L-arginine can then be converted into nitric oxide to aid in vasodilation and oxygen delivery. The production of NO has been shown to enhance recovery processes, exercise performance, mitochondrial respiration, muscle contractility, muscle repair, adaptations to resistance exercise, and glycogen uptake (2, 7, 8). Supplementing with L-citrulline is thought to be more effective than supplementing with L-arginine because unlike L-arginine, L-citrulline is able to bypass hepatic metabolism and be directly transported to the kidneys for metabolism (7). This process has been shown to result in more than 80% of citrulline being recycled to endothelial cells for NO production (4, 8). Lastly, malate encourages oxidative energy turnover through its roles as a Krebs cycle intermediate, which may behave as a metabolic shuttle between the cytoplasm and mitochondria to help increase the rate of adenosine triphosphate production (4, 7). Citrulline Malate’s effect on NO production, Krebs cycle functioning, and byproduct clearance suggests that it could have a significant effect on aerobic metabolism while alleviating a rapid onset of fatigue. Although the results on effectiveness of acute supplementation are mixed, it has been proposed that regular consumption may promote a more significant ergogenic benefit.

METHODS, cont.

PURPOSE

The purpose of this study was to investigate the effects of acute vs. chronic citrulline malate supplementation on muscle fatigue among healthy male participants.

RESULTS

Figure 1: Supplement x Time Interaction for Peak Power.

The change in peak power from BL to D1 (p=0.759), and from BL to D2 (p=0.818) did not differ between supplements.

Figure 2: Supplement x Time Interaction for Torque.

The change in peak torque from BL to D1 (p=0.940), and from BL to D2 (p=0.829) did not differ between supplements.

Figure 3: Supplement x Time Interaction for Fatigue Rate.

The change in fatigue rate from BL to D1(p=0.631), and from BL to D2 (p=0.723) did not differ between supplements.

CONCLUSIONS

The results of this study suggest that acute and chronic supplementation of CM had no impact on recovery or fatigue rate of the quadriceps following 30 min of continuous cycling. There were no statistically significant differences within the quadriceps when measuring for torque, power, work or fatigue rate while performing maximal voluntary knee extensions on the Biodynamics dynamometer. To our knowledge, the next future research should incorporate protocols that promote a high metabolic demand while consuming CM chronically.

REFERENCES