

Some amino acids associated with physical and mental fatigue

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Physical and mental fatigue, particularly in relation to immunodepression and the incidence of illness have been of interest to my group for many years. The amino acids of particular interest have been glutamine (Gln), the branched chain amino acids (BCAA), tryptophan (Trp), glutamate (Glu) and alanine (Ala). Our studies have investigated these in endurance athletes, in patients after major surgery or stroke or with chronic fatigue syndrome, and in short-term sleep deprivation. In addition to aspects of immune function, mood profiles were assessed. Trp was investigated in relation to fatigue using functional magnetic resonance imaging of the brain. After prolonged, exhaustive exercise, individuals involved in our studies had a notably high incidence of upper respiratory tract infections (URTI).

Clinical studies indicate that Gln feeding contributes to the alleviation of infections and improved gastrointestinal function. A reduction in URTI in endurance athletes has been attributed to supplementary feeding with Gln or the Gln precursors, BCAA. However, the situation is not clear with regard to the precise effect on the immune system of Gln, which is decreased after prolonged, exhaustive exercise. Glutaminase has recently been observed to be present on the secondary granules of human neutrophils, indicating that these cells utilize Gln. The transient immunodepression observed after prolonged, exhaustive exercise may be sufficiently short term for the body to recover rapidly and effectively with adequate nutrition. Nevertheless, repeated bouts of exhausting exercise undertaken in close succession, may lead to more chronic immunodepression for which rapid Gln repletion might prove beneficial.

In addition to being precursors of Gln, the BCAA have been discussed as having an important role in the central fatigue hypothesis, as has tryptophan. The plasma glutamine/glutamate ratio has been suggested as a marker for unexplained underperformance syndrome (also known as overtraining). Alanine may be a marker of fatigue.

Kinetics of creatine ingested as a component of a food bar

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The purpose of the present study was to test if the consumption of creatine incorporated in food bars modifies creatine plasma kinetics, erythrocyte retention and loss in urine and in feces when compared with its ingestion in the form of an aqueous solution (AS). Seventeen healthy young men ingested 2 g creatine either in the form of AS, or incorporated in a protein (PP) or in a beta-glucan (BG) rich food bar. Kinetics of plasma creatine was measured during 8 h and urinary excretion during 24 h. Then, the subjects received three times a day the same treatment for one week at the end of which creatine contents were determined in erythrocytes and in feces ($n = 4$ for feces). All subjects were experienced with the three treatments interspaced by a wash-out of four weeks. Absorption of creatine was slowed down by 8-fold in the presence of BG ($P < 0.001$) and by 4-fold with PP ($P < 0.001$) whereas the velocity rate constant of elimination and the area under the curve were not modified. Urinary loss of creatine in the first 24 h following ingestion was $15 \pm 1.9\%$ in AS and $14 \pm 2.2\%$ in PP conditions (NS) whereas it was only $8 \pm 1.2\%$ with BG ($P = 0.004$). Increase in creatine concentration in erythrocyte was similar whatever the form of creatine ingested.

Creatine seems to be totally absorbed since no creatine or creatinine was detectable in feces. No side effect was reported. Ingestion of creatine combined with BG facilitates its retention by slowing down its absorption rate to a sufficient extent to reduce urinary excretion.

Short-term changes in gene expression by creatine and resistance exercise in human skeletal muscle

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Having previously shown that creatine supplementation with or without subsequent resistance exercise has no short term effects on muscle protein synthesis, we were interested in testing the hypothesis that there might be longer term effects which are preceded by alterations in gene expression. The present study was designed to assess short-term changes in gene expression and activation of signalling pathways induced by a single bout of exercise after creatine supplementation. Nine subjects received either creatine or a placebo (3×7 g) for 5 d in a double-blind fashion before undergoing 4 muscle biopsies: at rest, immediately after exercise, and 24 and 72 h later. All biopsies were taken in the fasted state. The exercise consisted in 10 sets of 10 repetitions of one leg-extension at 80% of 1-RM. Previous creatine supplementation decreased the phosphorylation state of PKB on Thr308 at rest by 60% ($P < 0.05$) and the phosphorylation state of 4E-BP1 by 30% 24 h post-exercise ($P < 0.05$). Creatine increased collagen 1(α 1), GLUT-4 and MHCI (myosin heavy chain I) mRNA at rest by 250% ($P < 0.05$), 45% ($P < 0.05$) and 80% ($P < 0.05$), respectively, and MHCIIA (myosin heavy chain IIA) mRNA immediately after exercise by 70% ($P < 0.05$). Immediately after exercise, the mRNA transcription of MAFbx (muscle atrophy F-box), MHCIIA, PGC-1 α (peroxisome proliferator-activated receptor gamma coactivator-1 α) and IL-6 (interleukin-6) were up-regulated (+60% to +350%, $P < 0.05$) and the phosphorylation state of p38 was increased both in the sarcoplasm (12 fold, $P < 0.05$) and in the nucleus (25 fold, $P < 0.05$). At the same time, the phosphorylation state of PKB (protein kinase B) on Thr308 and 4E-BP1 (eukaryotic initiation factor 4E-binding protein) on Thr37/46 was decreased by 50 and 75%, respectively ($P < 0.05$). Twenty-four hours post-exercise, MAFbx, myostatin and GLUT-4 mRNA expression decreased below pre-exercise values (-35% to -50% , $P < 0.05$); calpain 1 increased by 70% 72 h post-exercise ($P < 0.05$) and at no other time. In conclusion, 5 d of creatine supplementation affects the expression of certain genes to a limited extent. The creatine-induced changes are unlikely to enhance those related to exercise alone. There seem to be little or no interaction between an increase in availability of creatine and other putative molecular changes leading to hypertrophy such as gene expression or anabolic signalling pathways.

Taurine and muscle activity

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Taurine, 2-amino ethanesulfonic acid, is a two carbon chain with an amino terminal function on one end and a sulfonic function on the other end. At physiological pH, most of the taurine molecules in solution are in a highly charged zwitterionic form which prevents their passage through the membrane lipid bi-layers. Taurine is the most abundant amino acid in many mammalian tissues with a typical concentration around 20 mM in