Effect of β-Alanine Supplementation on High-Intensity Exercise Performance

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Carnosine is a dipeptide of β-alanine and L-histidine found in high concentrations (in the millimolar range) in skeletal muscle. In human omnivores, the intracellular concentration may be as high as ~30 mmol•kg^{-1} dry muscle, whilst in equine muscle as high as 120–150 mmol•kg^{-1} dry muscle [1]. Highest concentrations of carnosine are found in fast twitch muscle fibers [2]. When combined with β-alanine, the pKa of the histidine imidazole ring is raised to ~6.8, placing it within the muscle pHi exercise-transit range. Combination with β-alanine further renders the dipeptide inert to intracellular enzymatic hydrolysis, and blocks the histidine residue from participation in proteogenesis, thus making it an ideal stable intracellular buffer.

In human vegetarians, synthesis of carnosine is limited by hepatic β-alanine synthesis from uracil degradation. Where muscle meat is eaten, hepatic synthesis is supplemented with β-alanine from the hydrolysis of dietary carnosine and methyl derivatives, supporting a higher concentration of muscle carnosine. The 'β-alanine' content of the modern omnivore diet is ~50–400 mg, but may have been much higher in the Paleolithic diet. Direct oral β-alanine supplementation will compensate for low meat and fish intake, significantly increasing the muscle carnosine concentration by as much as 80% within 10 weeks, above that maintained by a mixed diet [2]. Supplementation is best achieved using a sustained release formulation of β-alanine [3] to avoid symptoms of paresthesia and to decrease loss through urinary spillover [4, 5]. Acute strength training itself does not increase muscle carnosine synthesis or enhance the effect of β-alanine supplementation [6, 7], but chronic training with hypertrophy of fast twitch fibers will result in an apparent increase in muscle carnosine. Effects of gender and age have also been suggested [8], but apparent effects may be secondary to dietary differences/changes or changes in muscle fiber composition/characteristics.

In humans, increased levels of carnosine through β-alanine supplementation have been shown to increase exercise capacity and performance. In a meta-analysis of 15 studies, Hobson et al. [9] concluded that β-alanine was beneficial to performance in activities involving high-intensity exercise lasting 1–4 min. The net gains to performance (+2.8%) are of an order highly applicable to improvement performance to elite athletes. Recent data have also suggested β-alanine supplementation may also improve performance outcomes in the elderly. Thus, like creatine, β-alanine supplementation may be poised for use in muscle myopathies, and beyond the niche elite sport application.

References

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