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BETA-ALANINE SUPPLEMENTATION IN RESISTANCE TRAINING: A LITERATURE REVIEW OF EFFECTS ON STRENGTH, TRAINING VOLUME, AND RECOVERY

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ABSTRACT

Background: Beta-alanine is a widely used dietary supplement known for its role in increasing intramuscular carnosine concentrations and improving buffering capacity during high-intensity exercise. However, its effectiveness in resistance training and post-exercise recovery remains unclear. The aim of this narrative review is to evaluate current evidence regarding the effects of beta-alanine supplementation on strength performance, training volume, and recovery outcomes.
Methods: A literature search was conducted using PubMed, Scopus, and Google Scholar for studies published between 2015 and 2025. Randomized controlled trials, cohort studies, and systematic reviews examining beta-alanine supplementation in resistance-trained or physically active populations were included.
Results: The available evidence indicates that beta-alanine supplementation (typically 4–6 g day^{-1} for 2–4 weeks) effectively increases muscle carnosine content. However, the majority of studies show no significant improvements in maximal strength (e.g., one-repetition maximum), while findings regarding training volume and muscular endurance remain inconsistent. Evidence supporting a beneficial effect on post-exercise recovery is limited, with most studies reporting no significant changes in markers such as creatine kinase, lactate dehydrogenase, or muscle soreness.
Conclusion: Beta-alanine appears to be more effective as a fatigue-buffering supplement during high-intensity exercise than as a strategy to enhance maximal strength or accelerate recovery. Further well-controlled trials are needed to clarify its role in resistance training adaptations.

KEYWORDS

Beta-Alanine, Carnosine, Resistance Training, Muscle Recovery, Training Volume

CITATION

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1. Introduction

The growing popularity of dietary supplements to improve exercise performance and training adaptations is widespread among both professional athletes and individuals beginning sports training. One of the most widely used ergogenic supplements in sport is beta-alanine, which has gained popularity due to its well-established role in improving high-intensity exercise capacity and its favorable safety profile.

Beta-alanine is a non-essential amino acid naturally synthesized in the liver and serves as a rate-limiting precursor to carnosine synthesis. Chronic beta-alanine supplementation has been shown to increase intramuscular carnosine concentrations (Rezende et al., 2020; Roberts et al., 2020). Carnosine is synthesized in the human body from beta-alanine and histidine by the enzyme carnosine synthetase, with its production primarily limited by the availability of beta-alanine (Cesak et al., 2023).

Once synthesized, carnosine plays an important role as an intracellular proton buffer, reducing exercise-induced decreases in pH, which may contribute to a reduction in muscle fatigue (Trexler et al., 2015).

Multiple studies and meta-analyses have demonstrated a small but relevant effect of beta-alanine supplementation on high-intensity exercise performance, particularly in activities lasting approximately 1 minute to 4 minutes. However, the more specific role and potential benefits in resistance training and post-exercise recovery remain less clear.

2. Methods

The analysis included publications published between 2015 and 2025. The literature search was conducted using the following electronic databases: PubMed, Google Scholar, and Scopus. The search strategy was based on combinations of the following keywords: “beta-alanine”, “resistance training”, “strength training”, “recovery”, “fatigue markers”, “carnosine”, and “paresthesia”. Relevant publications were selected through manual screening of search results, with particular emphasis on randomized controlled trials (RCTs), other controlled studies, cohort studies, systematic reviews, and meta-analyses.

3. Results

3.1 Supplementation Protocols and Safety

Beta-alanine supplementation protocols have been extensively investigated with respect to dosage, administration strategies, duration of supplementation, and exercise context (Ong et al., 2025). Current evidence indicates that its ergogenic effects are primarily dependent on cumulative intake, as increases in intramuscular carnosine occur progressively over time rather than acutely.

3.1.1 Dosage and Duration of Supplementation

Available evidence suggests that beta-alanine supplementation in doses ranging from 4 to 6 g day^{-1} for a minimum of 2–4 weeks is sufficient to significantly elevate muscle carnosine concentrations (Trexler et al., 2015). Longer supplementation periods, extending up to 10 weeks, may result in further increases, particularly when the total cumulative intake exceeds approximately 200 g. These findings support the existence of a dose-dependent relationship between total beta-alanine intake and physiological adaptations (Ong et al., 2025).

Importantly, the effectiveness of supplementation appears to depend more on total accumulated dose than on the timing of ingestion relative to exercise.

3.1.2 Dosing Strategies

Due to the dose-dependent occurrence of paresthesia, beta-alanine is typically administered in divided doses throughout the day. In practice, the total daily intake is commonly split into three to four smaller doses, which improves tolerability without compromising the effectiveness of muscle carnosine loading (Trexler et al., 2015). This approach is recommended primarily to minimize side effects rather than to enhance physiological efficacy, as larger single doses may still contribute to carnosine accumulation but are less well tolerated.

3.1.3 Side Effects and Safety

Beta-alanine supplementation is generally considered safe when consumed at recommended doses (up to 6.4 g day^{-1}) for periods of up to 24 weeks. The most commonly reported side effect is paresthesia, characterized by a transient and harmless tingling sensation, typically affecting the face and upper body (Dolan et al., 2019). Some studies have also reported minor increases in alanine aminotransferase (ALT) levels; however, these changes are inconsistent and are not considered clinically significant (Dolan et al., 2019; Holeček, 2022). The mechanisms underlying paresthesia are not fully understood. It has been proposed that this effect may involve histamine-independent neural pathways, potentially through the activation of peripheral neuronal receptors such as MrgprD (Dolan et al., 2019). Alternatively, paresthesia may be associated with the activation of glycine receptor sites linked to N-methyl-D-aspartate (NMDA) receptors within the central nervous system (Maestre-Hernández et al., 2023). However, these mechanisms remain hypothetical and require further investigation.

3.2 Beta-Alanine in Resistance and Strength Training

The effects of beta-alanine supplementation in the context of resistance and strength training remain less consistent compared with its well-established role in high-intensity exercise performance. While its buffering capacity may theoretically support repeated efforts and training volume, empirical findings in resistance-trained populations are mixed.

3.2.1 Maximal Strength

Most studies indicate that beta-alanine supplementation does not significantly improve maximal strength outcomes, such as one-repetition maximum (1RM). In a study by de Camargo et al.et al. on resistance-trained men, eight weeks of supplementation with 6.4 g day^{-1} of beta-alanine did not result in significant differences in 1RM performance compared with the placebo group (de Camargo et al., 2023).

Likewise, a study by DE Araujo Pessôa et al., which incorporated blood flow restriction training, also failed to demonstrate significant effects of beta-alanine supplementation on maximal strength outcomes (DE Araujo Pessôa et al., 2023). In contrast, Maté-Muñoz et al. reported a significant increase in 1RM values after

five weeks of supplementation with 6.4 g day^{-1} in resistance-trained males compared to a non-supplemented control group (Maté-Muñoz et al., 2018).

Collectively, these findings suggest that beta-alanine supplementation has limited influence on maximal strength development, likely due to the predominant role of neuromuscular and mechanical factors in maximal force production rather than metabolic buffering capacity.

3.2.2 Training Volume

In contrast to maximal strength, beta-alanine supplementation may exert a more pronounced effect on training volume and muscular endurance. Some studies have reported significant increases in the total number of repetitions performed and overall training volume in individuals supplemented with beta-alanine compared with the placebo (Brisola & Zagatto, 2019; Maté-Muñoz et al., 2018).

However, findings are not entirely consistent. For instance, de Camargo et al. did not observe significant differences between groups in the number of repetitions performed at 60% of 1RM or in total weekly training volume following beta-alanine supplementation (de Camargo et al., 2023).

These discrepancies may be attributed to differences in study design, training protocols, participant training status, and supplementation duration. Overall, current evidence suggests that beta-alanine may enhance training capacity under certain conditions, although its effects are not consistently observed across all resistance training protocols.

3.3 Beta-Alanine and Recovery

Current evidence on the effects of beta-alanine supplementation on post-exercise recovery remains limited and inconclusive.

A study conducted by Roveratti et al. examined the effects of 31 days of beta-alanine supplementation on recovery following high-intensity resistance exercise. The authors reported no significant differences between the beta-alanine and placebo groups in markers assessed over a 72-hour recovery period, including muscle soreness, creatine kinase (CK), and lactate levels (Roveratti et al., 2019).

Similar findings were reported by Moniri Hamzekolaee et al., who investigated male soccer players and observed no significant effects of beta-alanine supplementation on biochemical markers of muscle damage, such as CK and lactate dehydrogenase (LDH) (Moniri Hamzekolaee et al., 2023).

In contrast, a study conducted on female basketball players demonstrated lower post-exercise lactate accumulation in participants who supplemented with beta-alanine for four weeks compared with those receiving a placebo (Gholami et al., 2022).

Current evidence does not support a clear direct effect of beta-alanine supplementation on post-exercise recovery. Across the available studies, supplementation has generally failed to reduce delayed muscle soreness or improve biochemical markers of muscle damage and recovery, including creatine kinase and lactate dehydrogenase. At present, beta-alanine appears more defensible as a fatigue-buffering aid during exercise than as a recovery-oriented supplement.

4. Discussion

This review demonstrates that beta-alanine supplementation has a limited impact on maximal strength outcomes during resistance training. Most placebo-controlled trials conducted in resistance-trained individuals indicate that beta-alanine supplementation does not meaningfully enhance one-repetition maximum (1RM) performance (DE Araujo Pessôa et al., 2023; de Camargo et al., 2023). However, the available data remain inconclusive, because some studies have reported improvements in strength outcomes (Maté-Muñoz et al., 2018), suggesting the need for further research. Recent systematic reviews suggest that the ergogenic benefits of beta-alanine are not strongly expressed in maximal force production tasks, but rather in high-intensity efforts involving metabolic stress (Ong et al., 2025).

The recovery findings are also inconclusive. The absence of consistent improvements in soreness, CK, LDH, work output during recovery, or muscle contractility suggests that the supplement does not directly accelerate the post-exercise repair processes responsible for restoring muscle function (Moniri Hamzekolaee et al., 2023; Roveratti et al., 2019). The supplement may attenuate fatigue during exercise without necessarily enhancing recovery after exercise. The existing data support beta-alanine more strongly as an in-exercise fatigue-buffering aid than as a recovery-oriented intervention (Gholami et al., 2022).

From a practical perspective, beta-alanine may be most useful for athletes and physically active individuals who perform repeated, high-intensity, high-volume training such as running or cycling lasting longer than 1 minute, with smaller effects observed beyond approximately 4 minutes of activity (Lancha Junior

et al., 2015; Saunders et al., 2017; Trexler et al., 2015). By contrast, when the primary training objective is maximal strength, the current evidence does not justify strong expectations of benefit. Future research should include larger sample sizes, better standardization of training protocols and dietary control, more studies involving women, and recovery outcomes that are functionally meaningful, such as restoration of force production, session quality in the next workout, and readiness to train.

5. Conclusions

In summary, beta-alanine supplementation is an evidence-based strategy for increasing intramuscular carnosine concentrations, which contributes to improved performance during high-intensity exercise. However, its effectiveness in the context of resistance training remains limited and inconsistent.

Current evidence does not support a significant impact of beta-alanine supplementation on maximal strength development, while its effects on training volume remain inconsistent. Furthermore, there is insufficient evidence to confirm its role in enhancing post-exercise recovery, as most studies report no meaningful effects on markers of muscle damage or delayed onset muscle soreness.

To better understand the role of beta-alanine in resistance training, future research should focus on large-scale, well-controlled randomized trials conducted in resistance-trained populations. Particular emphasis should be placed on standardized training protocols, dietary control, and the inclusion of functionally relevant performance and recovery outcomes. Additionally, further investigation into combined supplementation strategies and their potential synergistic effects may provide valuable insights for optimizing training adaptations and performance.

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