



BUFFERS: PERSPECTIVES ON USE IN ISOLATION OR COMBINATION FOR PHYSICAL PERFORMANCE IN MALES AND FEMALES

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BUFFERING AGENTS

Extracellular Buffering Agents

Extracellular buffering agents include sodium bicarbonate and sodium citrate and can increase the blood's buffering capacity (pH and $[\text{HCO}_3^-]$).¹ Performance benefits of ~2% have been reported after sodium bicarbonate supplementation, for high-intensity exercise of 30 seconds to 10 min duration, which may be relevant to events such as 400 m running and 100 m swimming.^{1,2}

Intracellular buffering agents

Beta-alanine ingestion can increase muscle carnosine concentration and enhance muscle buffering capacity.^{3,4} Performance benefits of up to 3% have been observed after beta-alanine supplementation, in high-intensity continuous and intermittent exercise tasks of 30 seconds to 10 min duration, such as team sports and track cycling events.⁵

EVIDENCE-BASED RECOMMENDATIONS FOR BUFFERING AGENTS

Recommendations have been established for the ingestion of extracellular and intracellular buffering agents (Figure 1). Recently, it has been established that specific factors (e.g., dose, timing of ingestion, co-ingested foods) can impact the effect of extracellular and intracellular buffering agents.^{1,7,8} Therefore, when implementing evidence-based recommendations for buffering agents, repeated trials with individual athletes, monitored by their support team (e.g., sport scientist and sports dietitian) are recommended^{6,9} which may facilitate small changes to ingestion protocols for individual athletes, as described in the next section.

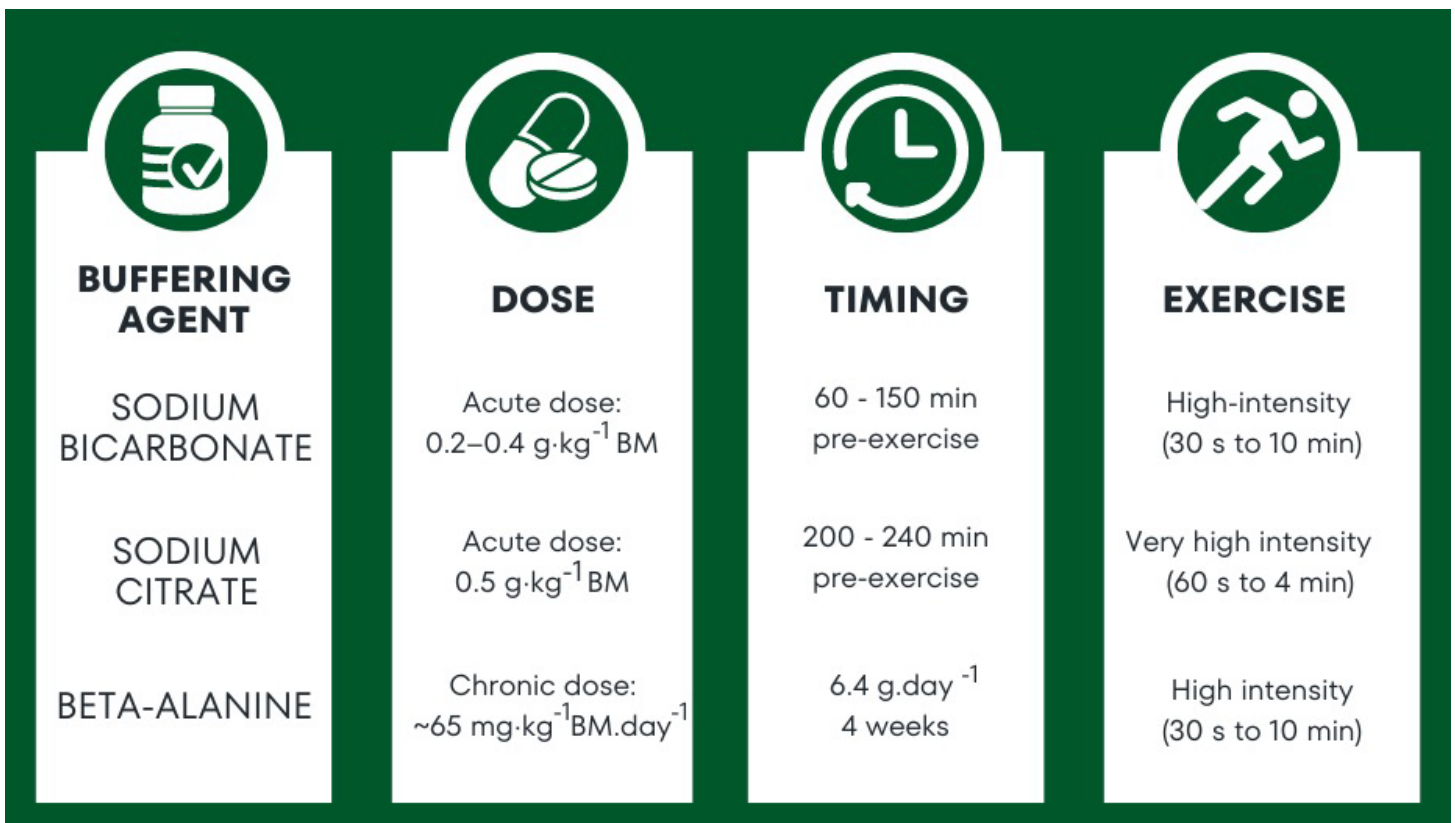


Figure 1: Current recommendations for buffering agents.^{1,5,6,7}

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IMPLEMENTATION OF EVIDENCE-BASED RECOMMENDATIONS FOR BUFFERING AGENTS

Extracellular Buffering Agents

Dose: Modifications within the range of recommended doses of sodium bicarbonate (0.2-0.4 g·kg⁻¹ BM) or the use of several sub-divided doses may be implemented, based on responses to specific doses.¹⁰ The ingestion of sodium bicarbonate and sodium citrate in capsules rather than solution may reduce the incidence of gastrointestinal symptoms.^{11,12}

Timing: Changes within the range of recommended timing for sodium bicarbonate (60-150 min pre-exercise) and sodium citrate (200-240 min pre-exercise) may be made in response to the timing of gastrointestinal symptoms and/or increases in blood buffering capacity. An increase of at least 4 mmol·L⁻¹ blood bicarbonate concentration ([HCO₃⁻]) may increase the potential for performance benefit with sodium bicarbonate or sodium citrate.¹

Co-ingested foods: Ingestion of sodium bicarbonate and sodium citrate with a small, carbohydrate meal may reduce the incidence of gastrointestinal symptoms.^{11,12}

Intracellular Buffering Agents

Dose: An increased daily dose of beta-alanine (g) and supplementation duration (days) may increase muscle carnosine concentration and muscle buffering capacity.⁵

Timing: A sub-divided daily beta-alanine dose, ingested every 3-4 h at a dose of 0.8-1.6 g may reduce side effects such as itches, rashes and tingling of the skin (paraesthesia).¹³

Co-ingested foods: Ingestion of beta-alanine with carbohydrate-rich meals may reduce the incidence of side effects.⁸

FUTURE RESEARCH DIRECTIONS: ATHLETES' USE OF BUFFERING AGENTS IN SPECIFIC CONTEXTS

Given the high prevalence of supplement and buffering agent use within athletic populations,^{6,14} consideration of the use of buffering agents in specific contexts relevant to athletes is therefore warranted. Contexts that have been investigated within the literature to some extent include the use of buffering agents in specific populations (e.g., high-performance female athletes),¹⁵ extreme environmental conditions (e.g., training and/or competing in hot weather conditions or at altitude)^{16,17} and specific supplementation practices (e.g., use of combined buffering agents).⁵ Within the broad body of research on the effects of extracellular and intracellular buffering agents on athletic performance, there has been more limited research conducted on the effects of buffering agents within these contexts.

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