

Evaluating Popular Supplements Marketed to Improve Endurance or Work Capacity



Nearly everyone involved in the fitness industry is interested in seeking out supplements for improved health and/or performance. The allure of a pill that can work magic, or at least improve upon one's hard work is very appealing. There are countless products currently marketed as dietary ergogenic aids. Ergogenic aids can be any practice, pharmacological agent, clothing/equipment, tool or dietary supplement used to improve performance. Many fitness enthusiasts and athletes use dietary supplements in the hopes of improving their physique or dominance in a sport – but many supplements are actually ineffective for facilitating the claims confidently displayed on their label.

Consumers need to understand that the supplement industry is a market that is not strictly regulated like many food products. Manufacturers often make bold or untrue statements that are not backed by research, and many products are not regularly tested for their purity. Current laws do little to protect consumers from mislabeled, contaminated or unsafe ingredients in supplements.

Therefore it is often recommended to athletes who can get in major trouble if banned compounds in their system are detected prior to major competitions to purchase supplements from reputable companies and stick with products that are NSF certified. NSF certified products must undergo a banned substance screening process, a label claim review, a contaminant review that certifies the formulation of the product and checks for undeclared ingredients, and even facility audits including on-site inspections.

Furthermore, even if positive clinical studies exist using a dietary supplement of personal interest, there are a number of considerations for evaluating the supporting research such as:

- Was the study implemented on animals or humans? Test tube studies are not equivalent to human studies and there are many differences between rats/mice and humans. The problem here is that it can be often considered unethical to use humans in supplement studies if there are potential perceived risks to health.
- Is the population for which claims are applied identical to the population examined in the study (elderly vs. athlete)?
- Were external variables and the study placebo controlled?
- Were adequate techniques used?
- Were the trials randomized and a crossover design used? Randomization reduces the impact of external variables on the data while a cross-over design allows the same subjects to go through the trial with the treatment and a placebo for a clear comparison.
- How many subjects were sampled? Was it 20 or 2,000?
- Do other studies confirm the findings and was the study peer-reviewed?

For the purpose of this discussion we will review supplements marketed to increase endurance or work capacity - also known as "metabolics". Considering these terms are somewhat ambiguous they will be defined as:

Supplements that are purported or proven to improve aerobic capacity or fuel usage efficiency to perform greater work prior to exhaustion.

Before we dig into specific dietary supplements marketed as metabolic enhancers, it should be understood that many basic vitamins, minerals, water or macronutrients can be considered ergogenic aids if there is a relative deficiency. For example, fluids or carbohydrates are some of the most potent "ergogenic aids" amongst endurance athletes. Also, basic micronutrients such as iron, zinc, magnesium, potassium, folic acid and other B-complex vitamins can be useful supplements amongst athletes who engage in high-volume endurance or other training due to significantly elevated needs and losses in sweat. The following supplements will stray from the standard essential micro- and macronutrient lists that can serve as ergogenic aids as we will examine the compounds which may promote improved performance even when there is no present defined deficiency.

Top supplements purported to enhance endurance and work capacity (metabolics):

■ **Beetroot Extract:** This one is promising when used with adequate dosing. Beetroot contains powerful antioxidants called anthocyanins. Once ingested, dietary nitrates in the root are efficiently converted into nitric oxide in the body. Nitric oxide serves as a powerful vasodilator which can increase blood and oxygen delivery to working muscles; therefore, beetroot potentially lowers the oxygen cost of exercise and reduces RPE during continuous work. The researchsupported dose is ~16 oz. taken 2.5 hours before activity. It appears to work best for moderate-duration, high-intensity bouts of work but more research is still needed.



- **Caffeine:** Everyone recognizes the benefits of this performance-boosting compound. It can enhance endurance and function as a metabolic by improving work capacity, lowering RPE levels and increasing time-to-exhaustion by 10-20% when training at high intensities (≥85% VO₂max). The recommended dosage for endurance benefits is 1.0-3.2 mg/kg of body weight depending on sensitivity and other variables. It also enhances work capacity during maximal exercise lasting <5 minutes or speed-endurance bursts lasting 60-180 seconds. It may also enhance endurance by improving carbohydrate absorption but more research is needed on this point. It works by potentially sparing muscle glycogen via increased lipolysis, increasing muscle fiber excitability via enzyme activity and influencing signals to the brain which can lower the perception of fatigue.
- **Beta-alanine:** This amino acid aids in the synthesis of carnosine, a dipeptide found within muscle fibers that is essential for maintaining an optimal pH within the tissue. Carnosine essentially works as a natural buffer, allowing the muscle to keep working. Therefore, the purported claim of beta-alanine is that is can increase power, strength and muscle anaerobic endurance as well as aerobic capacity - allowing an athlete to train longer. Research recommends dosages of 320-640 mg/day to function as an effective fatigue-preventer. It may be most useful for female athletes and vegetarians who have lower storage capacities and intake levels, respectively.
- **Glycerol and Tyrosine:** These two compounds may function as endurance-enhancers specifically while training in the heat – via increased resistance to thermoregulatory stress and the prevention of fatigue, respectively. Glycerol is purported to increase water retention and absorption but must be taken in multiple intervals at 5 ml/kg of body weight starting 2.5 hours before the bout of exercise (150, 120, 105, 90 and 60 minutes before). It also must be taken with large amounts of water. Common side-effects include nausea, headache, GI distress or dizziness and its true ergogenic effects are still somewhat un-

- clear. Tyrosine on the other hand is an amino acid that has been shown to attenuate CNS fatigue created by any increases in brain temperature experienced while training in the heat/humidity. Ingestion increases circulating concentrations of epinephrine, norepinephrine, and dopamine which may improve fuel use and reduce stress. Research recommends ingesting 75 mg/pound of body weight one hour before training for best results.
- **Lactic Acid Buffers:** There are a few compounds such as sodium bicarbonate, sodium citrate, and sodium phosphate which can serve as effective acidity buffers during high-intensity, short-duration work such as maximal sprints. Sodium bicarbonate can buffer acid during work lasting 1-3 minutes. Dosage is recommended at 300 mg/kg of body weight 60-90 minutes before the event. Sodium citrate can prevent performance-reducing acidity for work lasting 2-4 minutes. Dosage is 300-500 mg/kg of body weight, also 60-90 minutes before the event. Sodium phosphate may help improve one's anaerobic threshold (usually 4 mmol/L) by taking four doses of 1g daily for a total of 3-6 days before an event. Side effects for these types of compounds can include bloating, diarrhea and abdominal pain.
- **Choline:** Purported to thwart fatigue, but research is lacking. It is a precursor of acetylcholine and abundant in meat/dairy products. It gained attention from a study that found a 40% reduction of choline



levels in blood plasma following a marathon. However, supplement claims are based largely on theory and "test tube" studies. Interesting finds have occurred during human studies but grounds to classify it as an ergogenic aid are insufficient.

■ **Bee Pollen:** Purported to increase energy levels, physical fitness, endurance, and immune function. Some claim it can aid in weight control, increase longevity, reduce free radical damage, and even help prevent asthma. As a supplement it includes bee saliva, plant nectar, and pollen containing a mixture of vitamins, minerals and amino acids. It may be healthful but it does not seem effective as an ergogenic aid as research shows no effect on O₂ uptake, exercise performance or metabolism.

There are nearly countless products touted as metabolics that improve endurance, fuel economy, lower RPE or resistance to muscular stress. Many supplements fall into categories which could arguably make them a metabolic, such as L-glutamine or creatine, but many do not directly improve endurance as they function for different benefits – or do not work at all. Other supplements purported to function as metabolics but do not have a convincible degree of research to back their claims. Such supplements include, but are not limited to: polylactate (intolerable by GI tract), lecithin, fish oil (omega-3 fatty acids not ergogenic), inosine (actually ergolytic), pangamic acid, pyruvate combined with DHA, coenzyme Q10 (useful for cardiac patient but not athletes), cordyceps, acetylcysteine, Fenugreek herb and ginseng. There are also other weight loss supplements such as synephrine which may improve work capacity through means similar to caffeine – but they are not without their unfavorable health risks (e.g., cardiac events, arrhythmias) or are classified as controlled substances.

New research is continually emerging on supplements and their efficacy, but for now research supports the following supplements for endurance improvements:

- Caffeine (seemingly best choice)
- Beta-alanine if you have relatively low muscle mass or eat little meat
- **Beetroot extract**
- Lactic acid buffers
- And potentially **tyrosine** for training in the heat

