SCAN Nutrition Information Series

Evaluating Popular Sports Supplement

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Nutrition professionals often are asked to evaluate sports supplements that athletes currently use or are considering using. This article describes a method for evaluating popular sports supplements. Three commonly used sports supplements—creatine, arginine, and green tea—are reviewed here to illustrate the application of this evaluation method.

Primary Considerations in Evaluating Supplements

When evaluating sports supplements, three major areas of concern must be addressed: 1) the safety and effectiveness of the supplement, 2) the doping status of the substance; and 3) the quality of the product.

Safety and Effectiveness

The two most critical questions to ask are: Is this supplement safe? And is it effective?[1] In considering the risks and benefits of supplement and drug use, credible information on safety and effectiveness is essential.[1] Safety is paramount, because as the Hippocratic Oath states: "Primum non nocere"-"First, do no harm."

The first step in determining effectiveness is to assess whether the claim made regarding the supplement is reasonable from a physiological perspective.[2] To determine this, the nutrition professional must ascertain whether the supplement's purported mechanism of action is biologically plausible. If the supplement is unfamiliar, registered dietitians can visit Web sites that sell the product to identify the ingredients and the supposed method of action.

The next step is to review the scientific literature and meticulously examine the quality and quantity of studies provided to support the safety and effectiveness of the supplement.[2,3] All supportive research should be published in a reputable peer-reviewed journal and cited in the National Library of Medicine database (PubMed) (www. ncbi.nlm.nih. gov/PubMed). The American Dietetic Association's practice paper on dietary supplements provides guidelines for critically appraising the scientific validity of research.[3] For specifics on many supplements, several resources are available on the Internet to help nutrition professionals evaluate sports supplements (see back page).

Doping Status

Once safety and effectiveness have been established, it is important to consider whether the sports supplement may cause the athlete to test positive for a prohibited substance.[1,4] Some apparently "safe" supplements contain ingredients not declared on the label that are prohibited by the doping regulations of the National Collegiate Athletic Association, International Olympic Committee, and World Anti-Doping Agency.

Contaminants that have been identified by these groups include a variety of anabolic androgenic steroids and ephedrine. Although the contamination usually is the result of poor manufacturing processes, there also is evidence of deliberate adulteration of products by manufacturers. As a result, an unsuspecting athlete may test positive for banned substances.[4-6] Innocent ingestion of prohibited substances is not an acceptable excuse. Athletes who test positive for banned substances are legally responsible and subject to penalties. Several organizations screen supplements for prohibited substances and certify products that pass testing (see back page).

The undeclared inclusion of contaminants in supplements is not uncommon. The Medical Commission of the International Olympic Committee found that of 634 tested nonhormonal nutritional supplements from 13 countries, 14.8% contained substances that would have led to a positive doping test but were not listed on the label.[5] Italian researchers found that 12.5% of 64 nutritional supplements contained banned substances (anabolic steroids and ephedrine) not declared on the label.[6]

Quality of the Product

As a final consideration, it is important to evaluate the quality of the sports supplement, because the Food and Drug Administration does not review supplements prior to their market entry. The following four factors should be examined when assessing supplement quality:

- Identity (Does the product's contents match what is printed on the label?)
- Potency (Does the product contain the amount of the ingredient claimed on the label?)
- Purity (Is the product free of unacceptable levels of contaminants?)
- Bioavailability (Does the ingredient break apart properly in the body so that it may be assimilated?)

Several organizations are involved in testing supplements and certifying products that pass tests for identity, potency, purity, and bioavailability (see back page). It is recommended that products receive certification from one of these organizations. Some manufacturers may make the claim that their products are "pharmaceutical quality," but such a claim is meaningless.

Example: Evaluating Creatine

Creatine is used widely by athletes to increase muscle mass and improve performance during repeated intervals of high-intensity, short-duration (<30 seconds) exercise. As phosphocreatine, creatine provides energy for high-power muscular performance via the phosphagen system. Supplemental

creatine increases total creatine by 10% to 30% and phosphocreatine stores by 10% to 40%.[7] Creatine supplementation also increases muscle cell volume and muscle fiber hypertrophy.[8] Thus, the purported performance benefits of creatine supplementation can be reasonably explained by creatine's methods of action—and, therefore, these claims are biologically plausible.

A substantial body of research suggests that creatine supplementation represents a safe method to enhance muscle size and strength during resistance training.[8,9] While there is no strong scientific evidence to support any adverse effects, to date few studies have focused on the safety of long-term creatine usage.[9] Daily supplementation with 5 g to 20 g of creatine for 0.25 to 5.6 years did not have any long-term detrimental effects on kidney or liver functions in highly trained college athletes.[10]

Although not all studies report significant results regarding efficacy, the majority of scientific data indicate that creatine appears to be an effective ergogenic aid for activities that involve repeated, short intervals of high-intensity exercise.[7-9] Short-term creatine supplementation (e.g., 20 g/day for 5-7 days) may improve work performed during sets of maximal effort muscle contractions and repetitive sprint performance by 5% to 15%.[7] Long-term creatine supplementation may promote significantly greater improvements in strength, fat-free mass, and high-intensity exercise performance.[7] Chronic creatine supplementation may allow the athlete to train harder and thereby achieve greater training adaptations and performance gains.[1,8]

Thus, creatine appears to be both a safe and effective supplement for athletes who want to increase muscle mass and improve performance during repeated bouts high-intensity exercise.

Example: Evaluating Arginine

Many athletes take "nitric oxide releasing" supplements containing arginine alpha-ketoglutarate to enhance muscle size and strength. The non-essential amino acid arginine is the substrate for the nitric oxide synthase enzyme, which catalyzes the oxidation of arginine to produce nitric oxide (a gas) and citrulline. Nitric oxide is a key signaling molecule in the cardiovascular system and promotes vasodilation.[11]

In theory, arginine alpha-ketoglutarate supplementation boosts nitric oxide production and enhances vasodilation. This increases blood flow and oxygen transport to the muscles and promotes an extended "muscle pump" during resistance training. The increased blood flow also enhances delivery of nutrients to the muscles and removal of wastes from the muscles. The purported result: dramatic increases in muscle size and strength.

The proposed method of action for arginine alpha-ketoglutarate stretches the bounds of credibility. In atherosclerosis, the endothelium has a reduced capacity to produce nitric oxide and dilate effectively. Healthy people, however, do not have reduced nitric oxide production or impaired endothelial vasodilation and, therefore, they are unlikely to benefit from arginine alpha-ketoglutarate supplements. There also is no evidence that arginine alpha-ketoglutarate supplements increase nitric oxide levels or blood flow to the muscles in healthy people.[11]

Measuring nitric oxide is no small achievement, because the gas is highly reactive and has a very short life. Clinical studies generally measure flow-mediated endothelium-dependent vasodilation of the brachial artery to evaluate the effect of arginine supplementation on the vascular system.[11]

There is evidence that supplemental arginine may be beneficial in the clinical setting for patients with atherosclerosis and associated endothelial dysfunction by improving endothelial function.[11] Arginine supplementation (6.6 g/day for 2 weeks) improved exercise tolerance and flow-mediated vasodilation of the brachial artery in patients with angina[12] and claudication.[13]

The majority of research suggests that arginine supplementation is safe and well-tolerated at doses of 12 g or less per day in healthy individuals and patients with atherosclerosis.[11-15] However, arginine is not recommended following acute myocardial infarction, as 9 g/day of arginine did not improve vascular stiffness measurements or ejection fraction but was associated with higher postinfarction mortality.[16]

Evans and colleagues examined responses to daily doses of 3, 9, 21, and 30 g of arginine for one week. Five of the 12 healthy participants noted adverse effects (primarily diarrhea) with the 21 g/day dose, and an additional five noted adverse effects (primarily diarrhea) with 30 g/day.[14]

Only one published study has evaluated the safety and efficacy of arginine alpha-ketoglutarate in resistance-trained adult men.[15] The subjects consumed 4 g of arginine alpha-ketoglutarate three times a day (n=20) or placebo (n=15) and engaged in periodized resistance training four days a week for eight weeks. The researchers found that 12 g/day of arginine alpha-ketoglutarate significantly increased one repetition max bench press, Wingate peak power performance, and plasma arginine levels, but it had no effect on body composition, total body water, isokinetic quadriceps muscle endurance, and aerobic capacity. The supplement appeared to be safe and well-tolerated.

Arginine alpha-ketoglutarate appears to be safe in doses up to 12 g/day, with the exception of its contraindicated use following acute myocardial infarction. However, the data is woefully inadequate to determine effectiveness. Only one study suggests that arginine alpha-ketoglutarate increases muscle strength, and there is no evidence that it increases muscle size. Further research on the safety and effectiveness of arginine alpha-ketoglutarate is warranted.

Example: Evaluating Green Tea Extract

A number of athletes and active people take green tea extract to increase their metabolic rate and promote weight loss. Green tea extract contains tea catechins (primarily epigallocatechin gallate [EGCG]) and caffeine.

In theory, the tea catechins and caffeine interact synergistically to augment and prolong the release of norepinephrine by the sympathetic nervous system. Tea catechins inhibit catechol-O-methyltransferase, the enzyme that

degrades norepinephrine. Caffeine inhibits phosphodiesterase, the enzyme that degrades cyclic AMP. The net result is that green tea extract (50 mg caffeine and 90 mg EGCG three times daily) may reduce two brakes along the pathway of norepinephrine-activated thermogenesis.[17]

The purported beneficial effects of green tea extract on metabolic rate and weight loss appear reasonable from a physiological standpoint. However, only a small number of studies have evaluated the supplement for this purpose, and the results are mixed.[17-20]

Several studies[17-18] have found that green tea extract significantly increased 24-hour energy expenditure by 4% to 8% (~80-179 kcal/day). Dosages studied were 50 mg caffeine and 90 mg EGCG three times daily, and 200 mg caffeine from guarana and 90, 200, 300, or 400 mg EGCG three times daily; these dosages are commonly found in green tea extract supplements). While the results of these studies are provocative, other investigations suggest that the acute effect of green extract on 24-hour energy expenditure does not translate into a sustained increase in metabolic rate or a clinically significant weight loss over time.[19,20] At present, the data is insufficient to support the claim that green tea extract promotes an increase in metabolic rate or weight loss.

While green tea is widely consumed as a beverage and generally regarded as safe, green tea extract may not be safe. There have been case reports of acute liver toxicity associated with the use of green tea extract.[21,22] It seems prudent to advise against using green tea extract until further research clarifies the safety and effectiveness of the supplement.

Conclusion

Discussing supplements with athletes is not easy. Nutrition professionals are concerned about safety, while athletes desire a competitive edge. After assessing the athlete's needs and goals, education should include the potential risks/benefits (including doping) of using the supplement and guidelines on choosing a quality supplement. If convincing data suggest that the supplement may endanger the athlete's health, it is prudent to advise against using the supplement, even if the supplement appears to be effective for the purpose taken.

Ultimately the decision to use supplements lies with the athlete. If the supplement is safe, regardless of effectiveness, consider working with the athlete to test the product on a trial basis, as this helps to establish credibility.[1,2]

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A summary of key points is provided on the back page.

Summary of Key Points

Evaluating Popular Sports Supplements

The two most critical questions to ask: Is the supplement safe? Is the supplement effective?

Safety and Effectiveness:

In considering the risks/benefits of use, credible information on safety and effectiveness is essential.
- Safety: Remember, "First, do no harm." (Hippocratic Oath)
- Effectiveness: Determine whether the purported mechanism of action for the supplement is biologically plausible.
- If the supplement is unfamiliar, visit Web sites that sell the product to determine the ingredient(s) and supposed method of action.

Review the scientific literature and meticulously examine the quality and quantity of studies that support the safety and effectiveness of the supplement:
- Supportive research should be published in a reputable peer-reviewed journal and cited in the National Library of Medicine database (PubMed)
- The American Dietetic Association's "Practice Paper of the American Dietetic Association: Dietary Supplements (*J Am Diet Assoc.* 2005;102:460-470) provides guidelines for critically appraising the scientific validity of research.

Seek out Internet resources that are available to assist in evaluating supplements (see box).

Doping Status:

Will the supplement cause the athlete to test positive for a prohibited substance?
- Some supplements contain ingredients not declared on the label that are prohibited by the doping regulations of national and international sports governing bodies.
- Organizations that screen supplements for prohibited substances and certify products that pass tests include:
  - ConsumerLab "Athletic Banned Substances Screening Program"
  - NSF Certified for Sport™

Quality of the Product:

Factors to consider when assessing supplement quality include:
- Identity, potency, purity, availability
- Organizations that test supplements and certify products that pass tests include:
  - NSF (www.nsf.org/consumer/dietary_supplements)
  - United States Pharmacopeia (www.usp.org/USPVerified/dietarySupplements)
  - ConsumerLab (www.consumerlab.com)

Athlete education should include potential risks/benefits (including doping) of supplement use and guidelines on choosing a quality supplement.
- Advise against using unsafe supplements, even if the supplement appears effective.
- Work with the athlete to test a safe supplement on a trial basis; this helps to establish credibility.
- Ultimately the decision to use supplements lies with the athlete.

Internet Resources to Aid in Evaluating Supplements

The following resources are available online to assist in the evaluation of supplement:
- ConsumerLab (www.consumerlab.com). Free information; not referenced. Access to Natural Products Encyclopedia by EBSCO for subscribers.
- Natural Products Encyclopedia by EBSCO (www.alleghanyregional.com/healthcontent.asp?page=/ choice/demonstration/TheNaturalPharmacist-Consumer). Free referenced monographs.
- Natural Medicine Comprehensive Database (www.naturaldatabase.com). Referenced monographs; subscription required.
- Dietary Supplement Information Bureau(tm) (www.supplementinfo.org). Free referenced information.
- Supplement Watch (www.supplementwatch.com). Free referenced information.
- National Library of Medicine database (www.ncbi.nlm.nih.gov/PubMed).

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