The Effect of Ergogenic Substances over Sports Performance

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Abstract

In performance sports, the recovery mechanism ensures trophic regeneration, restoring the homeostasis of the internal environment as well as the functional parameters before effort and even brings them to an optimal state. The complete analysis of 51 studies that included a total of 10,274 athletes shows that a share of 46% have constantly used supplements as a form of recovery in sports. Furthermore, many have been using these ergogenic substances in a chaotic way (quantity, frequency, duration). Not all "natural" nutritional supplements are safe; many studies have shown that excessive and long-term intake of such substances can be harmful to the body.

An appropriate diet is crucial in the recovery process in sports and several authors promote the idea of healthy eating habits, including products that improve reactions that may favour energy releasing responses or enzymatic responses (as biocatalysts) as well as substances that can accelerate post-effort biological compensation. In this context, this paper tries to update a series of recommendations regarding the use of ergogenic supplements and their role in increasing or prolonging sports performance.

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1. Background

During effort, functional systems adjust their activity in order to optimize the athletes’ body performance. Any value change in the physiological and metabolic parameters that go over the adaptive level limits will lead to overloading, accompanied by decreased exercise capacity. Most morphological and functional adaptations are a consequence of the sports training exercise. Their effects gradually accumulate over time leading to a

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physiological and biochemical efficiency increase starting from the intracellular level all the way to the entire body having improved outcomes in applied disciplines and sports events (Drăgan, 2002).

In order to obtain the highest performance, a long and sustained exercise is not enough in itself. It is also necessary to apply methods that can accelerate or facilitate body restoration processes and to shorten the offset period for energy expenditure.

2. Objective of the paper

Availability and usage of dietary supplements has increased dramatically in recent years. Statistics show that 50% of unsportsmanlike people, 75% of young athletes and elite athletes all use different ergogenic substances as a source of health and comfort after exercise or as a way of recovering in training (Office of Dietary Supplements of the National Institutes of Health, 2006).

This paper argues, once again, for the importance of recovery as a distinct process that follows training and uses its own methodology to eliminate the effects of fatigue induced by exercise, reducing the risk of a reduction in the athletes’ performance.

3. Discussions regarding to systematic review

Most times, however, people who incorporate such products do not have the necessary information regarding their proper administration or the effects that these substances can induce. Analyzing data found in literature and from a personal experience, I will present below the role of ergogenic substances in supporting sport effort, but also as a means of recovery, with a role in ensuring overcompensation.

3.1. The association of carbohydrates with proteins

The rapid restoration of glycogen stores is conditioned by functional characteristics of the body after exercise and nutrient properties. A hypersecretion of insulin after exercise provides a faster intracellular glucose transport and stimulates anabolic enzymes reactions with formation of glycogen. Therefore, during the period of recovery after exercise (especially in the first 2 hours) when the sensitivity of muscle cells under the insulin’s action is at a maximum level, the aim is to significantly increase insulin secretion. The combination of carbohydrates with protein in the rehydration drinks of athletes doubles the insulin secretors’ response and increases the rate of glycogen synthesis by 30% (Eberle, 2007).

Proteins stimulate the secretion of cholecystokinin, which slows down gastric evacuation. Therefore, too much protein can reduce the intake of fluid and electrolytes during recovery due to the increase of "gastric stasis". Maintaining an optimal evacuation of gastric contents is conditioned by a carbohydrate/protein ratio of 4/1, a proportion known as the "optimum restore ratio" (Ivy, Portman, 2004).

Associating arginine with glucose increases the restoration of glycogen in the muscle by 35% because the amino acid stimulates the release of insulin from the pancreas and promotes muscle metabolism after exercise using fat as an ergogenic source protecting the glycogen. In addition, it was discovered that leucine has properties that can stimulate pancreatic insulin release (Bernadot, 2006). Muscular glycogenesis is influenced by a moderate increase of carbohydrate-protein intake and decrease of fat, which modifies the production of cholecystokinin as well as the gastric evacuation rate.

In the first 2 hours post effort, special attention is given to the type of carbohydrate consumed due to the increased sensitivity of muscle fibres under the action of insulin. High glycemic index carbohydrates are preferred due to the rapid increase in blood sugar metabolism directing glycogen synthesis. In the next step, the ratio of "optimal recovery" should include medium glycemic index carbohydrates (to ensure increased glycogen stores), and by the next effort only index carbohydrates in the category of low glycemic carbohydrates should be
used (Eberle, 2007). Studies evidenced by Maughan show an improvement of aerobe capacity in athletes who followed such a diet program of recovery after exercise (carbohydrates with low glycemic index influenced the metabolic activity of the muscles) (Maughan, 2000).

The strategy which aims to increase the amount of muscle glycogen after exercise is one of the most discussed restoration means applied in various sports. Recent studies have shown, however, that in gymnasts and swimmers carbohydrate supplementation is not always indicated because every gram of glycogen deposited in the muscles accumulates 3 grams of water this way leading to overload that affects tissue and muscle fibre flexibility (Bernadot, 2006).

3.2. Creatine monohydrate

In the first few seconds of intense muscle activity, ATP is maintained relatively constant through the decomposition of phosphocreatine, a compound found in a declining quantity. Creatine can be synthesized in the body or ingested in the form of creatine monohydrate. It is assumed that a high concentration of this product increases potential energy in anaerobe activity, and therefore, more and more athletes are using this ergogenic supplement.

Despite all this, some studies highlight some disadvantages of creatine use. Except the risk of throwing the liver’s function off balance by repeated measuring of detention it was found out that all athletes who consumed the equivalent of 250 kcal carbohydrates before the experiment showed better results for the explosive force a compared to those who ingested 15 grams of monohydrate. At the same time, the carbohydrates support the high jump with no bodyweight change, while creatine may promote weight gain (Passwater, 2006).

Daily supplementation with 10-28 grams of creatine (administered in 4 doses) leads to the saturation of muscle tissue that can reach a maximum level after 5 days. Given the fact that the compound’s storage leads to water retention in the muscle cell and there is a risk of weight gain, it is recommended that the product should be administered only 5 days per month. Long-term consumption of monohydrate was not fully tested on people who do not perform sports; it is not exactly known how it will affect the body’s health status. In athletes, however, an individual evaluation of energy consumption is suggested before the administration of the substance (Bernadot, 2006).

3.3. Sodium bicarbonate

The accumulation of lactic acid in the blood and the muscle limits the activity of the glycolytic energy production system. The muscle fibres’ acidification inhibits the degradation of new glycogen molecules as glycolytic enzymes decrease. In addition, a low pH leads to calcium loss in the muscles, thus preventing contraction. Buffer systems or physico-chemical mechanisms reduce the blood’s pH deviation through their ability to neutralize acids or bases (Apostu, 2010). For this reason, athletes try to block acidity and prolong exercise capacity by drinking sodium bicarbonate whose structure allows excess lactate buffering.

The contradictory results of research conducted in recent years still make bicarbonate consumption questionable. Thus, although the presence of sodium in the compound’s structure promotes fluid retention in the muscles by reducing the lactic acid’s effect through its excretion, gastrointestinal distress and nausea present in many athletes indicate that caution is required when using the product. Administration of 300 mg sodium bicarbonate/kg lean body mass within 60 minutes prior to a sports speed tests showed an improvement of anaerobe capacity, which shows the ergogenic effect of the compound (Maughan, 2000).

When it comes to endurance exercise, however, this method does not benefit athletic performance. The conclusion was supported by evaluating the aerobe capacity of 6 runners who did not only not progress but they also showed gastrointestinal disorders (Eberle, 2007).
3.4. Antioxidants

Independently of the effort’s characteristics, sport performance supports the production of microlesions in the muscle tissue and decreases the immune capacity of the body due to the accumulation of toxic substances (metabolite acids, free radicals). From a structural point of view, these are labile and interact with the phospholipids of the cellular and intracellular membranes, leading to the appearance of microlesions and the release of toxic substances that will inactivate a number of enzyme systems. Furthermore, free radicals are partly responsible for inflammatory-type symptoms manifested after intense efforts (Guyton, 1996).

The body’s protection against the harmful effect of free radicals is ensured by using antioxidant substances during the recovery period. Glutathione and superoxide dismutase are synthetic compounds belonging to the body’s own detoxification action. The glutathione (produced in the liver) provides cellular protection by inhibiting the synthesis of free radicals and superoxide dismutase neutralizes superoxide (the most common free radical) and empowers the action of other antioxidants (Powers & Howley, 2004).

During periods of intense training, not even balanced diets may provide enough antioxidant intake. Therefore, diets should be supplemented with vitamins (C and E) and minerals (selenium) that oppose the toxic action of free radicals. Vitamin C reduces the free radicals produced during the effort, thereby preventing muscle microlesions, promoting the secretion of stress hormones and facilitating tissue repair. Vitamin E ensures muscle relaxation (for cramps), promotes cell reconstruction processes and inhibits auto oxidation of membrane phospholipids. Experiments conducted on athletes have shown that taking a daily amount of 400 i.u. vitamin E lowers the risk of intramuscular microlesions by 25% during training and provides protection against muscle hypotrophy during holidays or traumatic recovery periods (Eberle, 2007).

The association of the two vitamins increases the antioxidating effect on the free radicals due to their synergistic action: vitamin E ensures the elimination of free radicals form the cell membranes and vitamin C attacks and destroys free radicals (Eberle, 2007).

Physical effort can affect the immune system by decreasing the efficiency of the leukocytes to defend the body’s autoinfection with negative effect on athletic performance in training or competition. Under the circumstances, maintaining spontaneous healing potential can be achieved by recovery diet supplementation with selenium, a strong antioxidating element.

3.5. Ginseng

Ginseng has been used in traditional medicine for over 1700 years to treat fatigue and increase the body's immune defense capacity. It becomes a valuable recovery supplement for athletes, both for its effect to stimulate the immune and cardiovascular systems, as well as for the action of reducing heart rate during the effort. Experimental studies (Powers, Howley, 2010) revealed that the use of Siberian ginseng extract in athletes limits the production of lactic acid during physical activity and accelerates its disposal from the body according to the intensity of the effort. Bernardot (2006) attributed ergogenic properties to ginseng when taken in doses of 8-16 mg/kg muscle mass only in endurance effort. The compound promotes oxygen transport to the muscles and increases the flow of lipids to metabolism energy protecting glycogen deposits.

3.6. L-Carnitine

Nowadays L-carnitine is one of the most popular supplements used as ergogenic aid for athletes, as for the unsporting population in preventing and treating diseases. The compound is synthesized in the liver and kidneys from lysine and methionine (essential amino acids). Due to its involvement in the metabolism of fats (by mobilizing long-chain fatty acids in catabolic reactions) and its beneficial influence on lipid profile (reduction in
triglyceride levels and increased HDL-"high density lipoprotein"), L-carnitine is considered by many specialists to be an important antioxidant supplement (Eberle, 2007).

When it comes to elite athletes, the effectiveness of L-carnitine supplementation is mainly based on deductive reasoning, knowing that the substance facilitates the passage of acids in the mitochondria where the fatty acids are quickly oxidized. On the other hand, the use of fats in energy production protects the storage of glycogen, increases the time for developing muscular fatigue and leads to weight loss.

The studies regarding the consumption of L-carnitine associated with a low calorie diet and physical exercise, even if less numerous, have shown a significant decrease of body weight, especially in the case of athletes required to compete in certain weight categories. The accepted ideal dose is between 2 and 6 grams per day without adverse physiological events. Overdosing on this compound is also considered to have no risk of toxicity (Bernadot, 2006).

3.7. Caffeine

The alkaloid from the purine group which is found in coffee, tea or chocolate stimulates the central nervous system and relaxes skeletal muscles. Caffeine ingestion significantly increases plasma concentrations of free fatty acids which stimulate lipid catabolism and protects glycogen stores (Power, Howley, 2004).

Recently removed from the list of prohibited substances, caffeine has been the subject of numerous studies on athletes. It was experimentally shown that an intake of 3-9 mg/kg body weight improves the aerobe effort capacity of endurance athletes by 7 and up to 35%, indicating that the rate of increase in performance is directly proportional to the doses administered. In addition, caffeine consumption reduces muscle pain after exercise by 48%, in beginner athletes (Bernadot, 2006). Regular consumption, as well as increasing intake install and minimize dependence on the ergogenic effect of caffeine due to the adaptation process of the body. In addition, the excess of caffeine can induce diuresis with the installation of dehydration, while using the product discontinuously can cause irritability, headache, anxiety. Despite its ergogenic properties, athletes are advised to be cautious when it comes to caffeine intake and to consult specialists regarding the effects of caffeine excess on the health of the body.

4. Conclusions

The nutritional supplements industry has gone through a surprising evolution in recent years, powered by the athletes’ permanent desire to improve performance. Athletes are increasingly tempted to use ergogenic substances that can contribute to adjusting strength, endurance, recovery of exercise capacity or body composition, provided that the category of ergogenic aids contains both natural substances and those considered prohibited by specialist sports forums. Although there is a lot of information regarding this topic, modern athletes are a paradox: on the one hand they are the symbols of a healthy life, which consists in rational training and a balanced diet, and they are constantly monitored by specialized medical personnel, and on the other hand they are constantly tempted to use substances with potential negative risks, that are not very well known.

Due to this fact, athletes must become thoroughly familiar with the ergogenic phenomenon based on serious scientific studies, credible in supporting those who wish to obtain performance and not working against them. Collaboration between athletes, coaches and sports nutrition specialists in athletic training is required, the latter providing accurate indications about the benefits, effects and risks associated with the use of ergogenic substances (intake of products containing illegal substances or unjustified expenses).

References