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Vitamin C as an Ergogenic Aid

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Abstract

Athletes are always searching for legal nutritional supplements that will give them a significant advantage over their competitors. We will present vitamin C (ascorbic acid) as a non-toxic, safe, multifaceted and effective ergogenic alternative. Vitamin C may have been neglected as an ergogenic aid mainly because of the lack of knowledge of ascorbate's biochemical and physiological functions when given in large doses especially by intravenous route. The mechanistic theory-model of how ascorbate may work as a novel ergogenic aid will be discussed herein.

Introduction

Nutritional ergogenic aids are primarily aimed at enhancing performance by either directly affecting energy metabolism in the muscle or stimulating the central nervous system. Other nutritional aids of indirect ergogenic activity are those utilized for augmentation of lean body mass (muscle mass) and those aimed at reducing body fat content. Although of not a strict ergogenic action, certain supplements are directed to increase resistance to infection and improve general health. These aids are also important in reducing the interruptions to training that illness and infection may cause. The use of supplementation for all these purposes is widespread.[1] In addition to the type of supplement, of great relevance is the amount and timing of the supplement and the specific exercise conditions under which its effects may be optimized. Most effective supplements are against the rules of the sport and many may also be unsafe. We will present vitamin C (ascorbic acid) as non-toxic, safe, multifaceted and effective ergogenic alternative.

Vitamin C may have been neglected as an ergogenic aid as it has been neglected in the treatment of many diseases (such as the common cold, cardiovascular disease and cancer) mainly because of the lack of knowledge of ascorbate's biochemical and physiological functions when given in large doses especially by intravenous route. The mechanistic theory-model of how ascorbate may work as a novel ergogenic aid will be discussed herein.

Discussion

Of great interest to athletes are supplements that may influence energy metabolism. We are presenting vitamin C (ascorbic acid) as an ergogenic aid when provided in large quantities especially when given intravenously.

Ascorbic acid is distributed in varying concentrations throughout the body and is involved in a variety of metabolic reactions related to exercise such as synthesis and activation of neuropeptides, formation and repair of collagen and synthesis of carnitine.[2] Once these facts are taken into account, it is conceivable that exercise may enhance the utilization, metabolism and excretion of ascorbic acid, thus increasing the body's requirements for vitamin C. The recommended daily allowance for vitamin C is between 30-60 mg daily. These doses are too low to detect any possible ergogenic activity of vitamin C.

One of the most recognized features of vitamin C is its antioxidant action. Vitamin C protects cells, especially muscle cells from harmful effects of highly reactive free radicals produced when the rate of oxygen consumption is substantially increased during strenuous exercise.[3] Exercise that forcibly lengthens muscle may result in

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damage to the muscle structure and post exercise soreness. This muscle soreness peaks one to three days after the exercise bout and is often referred to as delayed onset muscle soreness (DOMS). The pain associated with this condition is thought to be consequence of microtraumatization of connective tissue and microfibers. It has been reported that oral vitamin C (in doses of about 200 mg) may significantly reduce DOMS.[4] It has also been suggested with some preliminary evidence that vitamin C may benefit muscle function and reduce plasma levels of malondialdehyde, a secondary product of lipid peroxidation, in addition to diminishing muscle soreness.[3] Vitamin C also appears to offer protection against ultra structural damage following reperfusion injury.[5] Reduction in inflammation may explain the decreased soreness present in the vitamin C supplement group. Reduction in plasma concentration of pro-inflammatory cytokines such as 1L-6, TNF-alpha, 1L-8, have been reported following high dose oral supplementation of 1,500 mg of vitamin C.[6] High doses of vitamin C may also reduce cortisol.[2, 6-9] Athletes supplemented orally with 500-1,500 mg of vitamin C in the week before and on the day of the race significantly attenuated the post exercise serum cortisol responses.[8] High doses of vitamin C may inhibit the synthesis of cortisol, possibly through a pro-oxidant effect. As we have pointed out in other publications,[10, 11] ascorbic acid may act as a pro-oxidant under certain conditions. Interestingly, declines in plasma ascorbic acid correspond to a rapid and dramatic increased in plasma cortisol and ACTH concentrations.[2] It is conceivable that both cortisol and ascorbic acid have a regulatory influence on gluconeogenesis, an important energy mechanism.

Moreover Cheraskin reported[12] that subjects who consume less than 100 mg of ascorbic acid per day showed a higher fatigability mark than those ingesting more than 400 mg of ascorbate per day when performing the same activities. It has also been documented that in cancer patients high doses of ascorbic acid produce substantial benefits ranging from increase energy to the reduction of pain and tumor burden.[13-16] Cancer patients claim to feel better, more energetic, stronger, with increased mental alertness and they report improved appetite.

We used intravenous ascorbic acid as an ergogenic agent in the Basketball Pre-Olympic tournament of the Americas with the Puerto Rico National basketball team. We believe that this intervention helped them classify for the 2004 Olympic games in Athens, in which the Puerto Rican national team gave the USA dream team their first defeat in Olympic competition.

The question that follows is: What is the proposed mechanism by which ascorbic acid (in large doses) produces these ergogenic effects? Albert Szent-Györgyi, discoverer of vitamin C, believed that the real physiological significance of vitamin C should be ultimately looked for in the electron transport system.[17] Chemically, ascorbic acid exhibits redox characteristics as a reducing agent. Physiologically ascorbic acid provides electrons for enzymes and other electron acceptors. Szent-Györgyi explained that dead tissue had a full complement of electrons, while living tissue maintained a deficit of electrons. Vitamin C assures a continuing electron exchange among body tissues, cell mitochondria and molecules. All body functions are directly controlled and regulated by this physiological flow of electrons. Furthermore, this flow of electricity through the body also establishes and maintains the subtle magnetic fields in the body that appear to be involved in maintaining the healthy state. Vitamin C may be the most important stimulus to this flow of electricity. A greater amount of vitamin C in the body enhances the flow of electricity, optimizing the ability of the cells to maintain aerobic energy production and metabolic intermediaries that facilitates cell to cell communications. Disease exists when

this flow is impaired and death occurs when this flow stops. In support of this theory, it has been documented that osteoblast cells treated with ascorbic acid had four-fold increase in respiration, a threefold increase in ATP production that provided the necessary energy for cell differentiation.[18] Also ascorbate in high concentrations may reduce NADPH and therefore provide the high-energy electrons necessary for aerobic metabolism.[19] This redox activity of ascorbate at the level of the plasma membrane may be important not only in mitochondria energy production but in the regulation of cell growth as well.[20]

Conclusions

Athletes are always searching for legal nutritional supplements that will give them a significant advantage over their competitors. Also important in this quest is that any chemical substances to be used have no harmful side effects. Given the information presented herein, we propose vitamin C as an effective, non-toxic ergogenic agent.

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