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The Effects of Acid Ascorbic Consumption on Aerobic and Anaerobic Capacity

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ABSTRACT

In order to study the effects of consumption of 2 regimes of vitamin C (500 and 1000 mg) on bioenergetics index (aerobic and anaerobic power)in 36 physical education college male students, were selected non – randomly procedure and they were set in 3 groups .Average of age, weight, height and Fat percentage of subjects was (22.48 ± 1.84) years, (64.93 ± 7.84) kg (175.4 ± 5.66) cm and (10.94 ± 5.29) mm respectively. The period considered for consumption of vitamin C by experimental groups, was a 3 weeks period that in this period the first group consumed dose of (500 m.g) vitamin c and second group (1000 m.g) vitamin C and third group (control group) consumed placebo. The tests which have been exerted in this research consist of: assessment of anaerobic power by RAST test. 2) Assessment of aerobic power by Cooper test. Result indicated that there was not a significant (p <0.05) difference between 3 group in anaerobic and anaerobic power .Therefore we concluded that daily consumption of 500 or 1000 m.g vitamin C for a period of 3 week does not have any effect on the basis of improvement of anaerobic and aerobic power in male college students.

Key words: Aerobic power, anaerobic power, Antioxidant, performance

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INTRODUCTION

Ascorbic acid or vitamin C is involved in a number of biochemical pathways that are important to exercise metabolism and the health of exercising individuals. Vitamin, mineral and/or trace element supplements are beneficial if they supply a nutrient that is deficient in the diet. That is, when dietary intake is lower than the amount needed to provide maximum benefit as judged from all biological perspectives. It is difficult to accurately define nutrient «adequacy» in competitive athletes, for several reasons. First, requirements for vitamins and minerals vary: metabolic, environmental, and/or genetic factors can influence individual nutrient requirements. Second, physical activity and physical fitness are complex, involving multiple diverse components that are difficult to accurately and reliably measure. Third, a nutrient supplement that could improve performance by as little as 2–3% could provide a competitive edge; for example, reducing a 1500 m runner's time of 3 min 45 s by 6 s. In order to detect such small changes an intervention requires randomized, placebo-controlled, double-blind studies designed to maximize statistical power [1].Vitamin C has many functions within the human body. It is a water soluble vitamin vital in carnitine synthesis (needed for the transport of fatty acids into the mitochondria), Collagen formation, neurotransmitter synthesis, and most importantly, as an antioxidant. It also plays a part in the process to convert cholesterol to bile acids and aids iron absorption [2]. An important water-soluble vitamin is vitamin C, which has diverse functions including being an antioxidant, exerting positive effects on lipid and iron metabolism, and promoting improved immune function [17, 18].High doses of the antioxidant vitamin C prevent the increases in skeletal muscle mitochondrial biogenesis after exercise training[19].

For years, athletes have been supplementing with vitamin C with the belief that it will aid
or at least help to maintain athletic performance. As an antioxidant, ascorbic acid may react with OH (hydroxyl radical), O_{2-} (superoxide Radical), $H2O_2$ (hydrogen peroxide), and HO_2 (hydroperoxyl radical). Once ascorbate reacts with these ROS, semidehydroascorbate radical (also called ascorbyl) and water are formed. Two ascorbyls react to form ascorbate and dehydroascorbate [3]. Dehydroascorbate can react with glutathione to form ascorbate. As a reductant, vitamin C can reduce cupric (Cu^{2+}) to cuprous (Cu+) ions, and ferric (Fe3+) to ferrous (Fe2+) ions (which aids in their absorption in the small intestine). These two products (Cu+, Fe2+) may react with free radicals and other ROS, and may cause damage to cells via the generation of more ROS [4]. Ascorbate can react in aqueous environments within the body, including blood, extracellular fluid, and cell interiors, before any oxidative damage may occur to lipids [3].It is well accepted, that exercise causes an increase in the production of free radicals and other reactive oxygen species [5].A proliferation of these free radicals can cause a decrease in the function of affected cells and can result in a decreased ability of muscles to maintain work [5].Several investigators believe that the ingestion of antioxidants will help to stave off this proliferation of free radicals during exercise and thus provide a beneficial effect [6, 7].The established functions of antioxidant vitamins predispose them for improving physical work capacity. It is a known fact that the concentration of these vitamins increases after supplements yet further migration to tissues is hindered do to the structure and the accompanying biochemical properties, for example: water-soluble (vitamin C) and lipid-soluble (vitamin E) [8, 9].

In human subjects, supplementation with 400 mg ascorbic acid·d–1 for 3 wk increased blood ascorbic acid concentrations but did not significantly reduce plasma MDA after a bench-stepping exercise [100]. However, using the same supplementation schedule and exercise protocol, Jakeman and Maxwell [11] ,reported the ascorbic acid group showed reduced strength loss in the triceps surface after exercise and faster recovery, suggesting vitamin C supplementation reduced muscle damage. Delayed-onset muscle soreness may be an indicator of muscle damage induced by exercise. Staton [12] gave men 200 mg ascorbic acid·d–1 or placebo for 30 d, and then had them perform sit-up exercises to induce soreness. When they repeated the exercise 24 h later, the supplemented group was able to perform significantly more sit-ups than the placebo group. Oxidative stress is a state where the ROS production overcomes the antioxidant system’s ability to handle the ROS. Exercise-induced oxidative stress is a condition where the exercise has created a condition that produces ROS that cannot be adequately 2 handled by the antioxidant defense mechanisms of the system being measured. This exercise-induced oxidative stress can be produced through both aerobic exercise of sufficient intensity and duration, as well as high intensity exercise of short duration [13].The type of exercise, the intensity and duration of exercise, and the form of muscle contraction involved appear to be important factors for inducing oxidative stress. Concentric contractions (muscle actively shortening) during aerobic or intense short duration exercise has been reported to increase by-products of lipid breakdown, activate antioxidant defense mechanisms and decrease the amount of reduced thiols [14]. In contrast, eccentric contractions (muscle actively lengthening) that can result in greater muscle damage utilizes less oxygen for the muscle contraction. In addition, there are fewer muscle motor units recruited for the same or greater force in an eccentric action compared to a concentric muscle action [14] As a result there is a greater likelihood for muscle damage with eccentric types of contractions.

Recently, Bryer and Goldfarb [15] reported that this same dose of vitamin C could not only attenuate the delayed soreness to eccentric exercise but could also attenuate the increase in glutathione ratio but did not alter the leakage of proteins out of muscles as indicated by blood creatine kinase. More work is needed to determine if vitamin C can give protective effects to ROS damage of cardiac muscle. Goldfarb and Patrick [16] reported that both 500 mg and 1 gm of vitamin C given for two weeks prior to exercise could attenuate the exercise induced oxidative stress as indicated by a reduction in protein carbonyls. Based on the current literature, it can be concluded that antioxidant supplementation may partially protect against exercise induced oxidative stress. The results are inconsistent, which could be attributed to differences in subject, exercise modes, supplementation dosage and form, and the markers of oxidative stress measured. In this research the subjects were supplemented with a highly bioavailable antioxidant (vitamin C) over a period of 3 wks. The main objective of this study was to evaluate the effect of oral supplementation with vitamin C on aerobic and anaerobic power in male university students.

MATERIALS AND METHODS

Subjects

The research included 36 male students of physical education, randomly divided into 3 groups: Group 1 (n = 12) consumed 500 mg of vitamin C daily throughout the training period, and Group 2 (n = 12) consumed 1000 mg of vitamin C, whereas group 3 (n=12). Consumed visually identical placebo. All subjects were informed verbally and in writing about the nature and demands of the study, and subsequently they completed a health history questionnaire and gave their written informed consent. The study was approved by university's ethical advisory commission Página: 132 which conformed to the Declaration of Helsinki. Our selection of highly trained and motivated athletes for this study was based on our experience that competitive athletes are generally willing and able to withstand considerable discomfort and to exercise until the development of physiological signs of exhaustion.

. The subjects were in good health, were not using medications known to affect immune function, and had not consumed vitamin or mineral supplements more than the recommended dietary allowance within one week of the test. All participants regularly took part in a variety of activities but were unfamiliar with the tests used in the current investigation. Subjects 'descriptive data are presented in Table 1.

Table 1. Descriptive Characteristics of Experimental Subjects

Variable	Placebo (N=12)	Vitamin C (500mg) (N=12)	Vitamin C (1000mg) (N=12)
Age (years)	22.14±1.12	22.52±1.34	22.38± 1.27
Height (cm)	176.55±1.52	177.29±2.21	177.32±1.43
Weight (kg)	73.74±1.61	72.91±1.32	71.26±2.21
% Body fat	12.2 ± 4.5	13.3 ± 2.3	11.9 ± 3.6

**Results are expressed as mean ±standard deviation.*

Dietary Assessment

Three days prior to the baseline testing, athletes met a nutritionist who instructed them to maintain their normal dietary pattern throughout the course of the study and to refrain from using any other supplementation. During the supplementation regimen, all athletes consumed similar standardized diet to ensure adequate macro- and micronutrient intake (daily energy intake and protein intake were similar between the groups). Compliance was monitored by analyzing 3-d food records pre- and post-supplementation. The information therein was analyzed using the software Food Processor for Windows (version 7.30, ESHA Research, Oregon, USA).

Experimental Procedures

Before the supplementation protocol began, each subject compiled a 3-day food diary to assess the status of antioxidant vitamins. The diary length was selected based upon previous research that showed that beyond this time period, the quality of record keeping declines [5,20,21].Subjects' diaries were assessed for RDA levels of the selected vitamins using the software Food Processor for Windows. Subjects ingested antioxidant Vitamin C capsules consisting of 500 mg of vitamin C, or 1000 mg of vitamin C, or one placebo capsule. We carried out RAST and then the Cooper test on the subjects (pre-test).After pretest and under supervision of the researcher, the first group received cellulose-based placebo pills, the second group received 500 mg of vitamin C (in the form of ascorbic acid) and the third group received 1000 mg of vitamin C (in the form of ascorbic acid). The subjects ingested the supplement for 3 weeks before lunch, between 11:00 and 13.00 every day, under the supervision of the researcher. After 3 weeks the subjects between 15:00 and 18:00 completed the RAST and Cooper test again (post-test). Subjects completed six 35 m runs at maximum pace (10 s allowed between each sprint for turnaround). Power output in watts for each sprint was calculated according to the following equation: power =weight (kg) × distance (m) × time (s) [22]. Each subject's aerobic power was estimated by distance covered at 12 minute [23].

Statistical Analysis

Means and standard deviations were calculated for all variables, and for the intragroupal analysis the "One-Way ANOVA" was used with the Tukey test as post hoc. The level of significance was set for all analysis at $P < 0.05$. The data were analyzed using the statistical package SPSS, PC program (version 7.5, SPSS Inc., USA).

RESULTS

The analysis of the tested subject's diet is presented in table 2. The data indicates no significant difference in the caloric value of diets of there groups .The amount of vitamin C and E ,were consistent with RDA and after supplementation were much higher in the group supplemented with Zellschutz product.

There were no significant differences among the improvements in aerobic and anaerobic power between groups (Figure1,Table3; ($P < 0.05$). There were no significant differences between groups for their supplement compliance rate ($P < 0.05$).Analyses of the dietary recalls were demonstrated no significant differences in caloric intake between the groups. Furthermore, there were no differences in macronutrient daily intake, with there groups.

Table 2. Daily energy, macronutrient, vitamin C, vitamin E intake and contribution (%) of macronutrients to energy intake of subjects.

NUTRIENT	Group1 (N=12)	Group2 (N=12)	Group3 (N=12)
Total Energy Intake (Kcal)	3060 ± 626	3140 ± 604	3090±615
Carbohydrate ($Kcal.Kg^{-1}$)	52.7 ± 5.2	53.5 ± 4.6	51.2 ± 6.4
Protein ($Kcal.Kg^{-1}$)	1.6 ± 0.5	1.7 ± 0.4	1.8 ± 0.6
Vitamin E (mg)	3.1 ± 0.6	3.5 ± 0.4	3.2 ± 0.5
Vitamin C (mg)	28 ± 3.2	29 ± 1.1	27 ± 2.4
Carbohydrates (% of calories)	55 ± 10	51 ± 15	53 ± 10
Protein (% of calories)	16.6 ± 3.1	15.2 ± 2.4	14.4±4.3
Fat (% of calories)	30.5±3.2	29.5±4.2	29.6±2.5

**Results are expressed as mean ±standard deviation.*

Table 3.Performance parameters after 3 weeks of vitamin C (500 and 1000 mg) supplementation.

Performance Parameters	Group1 *PRE*	Group1 *POST*	Group2 *PRE*	Group2 *POST*	Group3 *PRE*	Group3 POST
Aerobic power ($ml.kg^{-1}.m^{-1}$)	50.4±4.5	50.7±5.2	50.6±3.7	50.7±4.3	49.9±5.6	50.2±4.2
Anaerobic power (Watt)	449	450	450	450	448	448

Data are means ±SD; Group1=500mg Vitamin C supplemented; Group2=1000mg Vitamin C supplemented; Group3=Placebo Group.

DISCUSSION

The present study was designed to determine whether antioxidant vitamin C supplementation influences bioenergetics index in male physical education students. Aerobic work capacity depends to a large extent on the effectiveness of the cardiovascular system and may be improved by physical training and supplementation [24]. Work capacity is also dependent on the synthesis of structural and enzymatic proteins. The last ones act as catalysts of chemical reactions, allowing the athlete to reach the steady state. This helps to supply the working muscles in ATP [25].Vitamin C is an essential cofactor in number of hydroxylases such as prolyl hydroxylase and lysyl hydroxylase. Since hydroxylation adds stability to the collagen triple helix, many of the symptoms of vitamin C deficiency, such as blood vessel fragility, can be traced to lack of proper collagen strength but in addition to its role in hydroxylation, vitamin C probably functions as an antioxidant. Vitamin C acts as a free radical scavenger, neutralizing such reactive oxygen species as superoxide hydrogen peroxide and hypochlorous acid in the process being converted to dehydroascorbic acid. Dehydroascorbic acid may be recycled to ascorbic acid by various mechanisms (e.g. glutathione) [25].

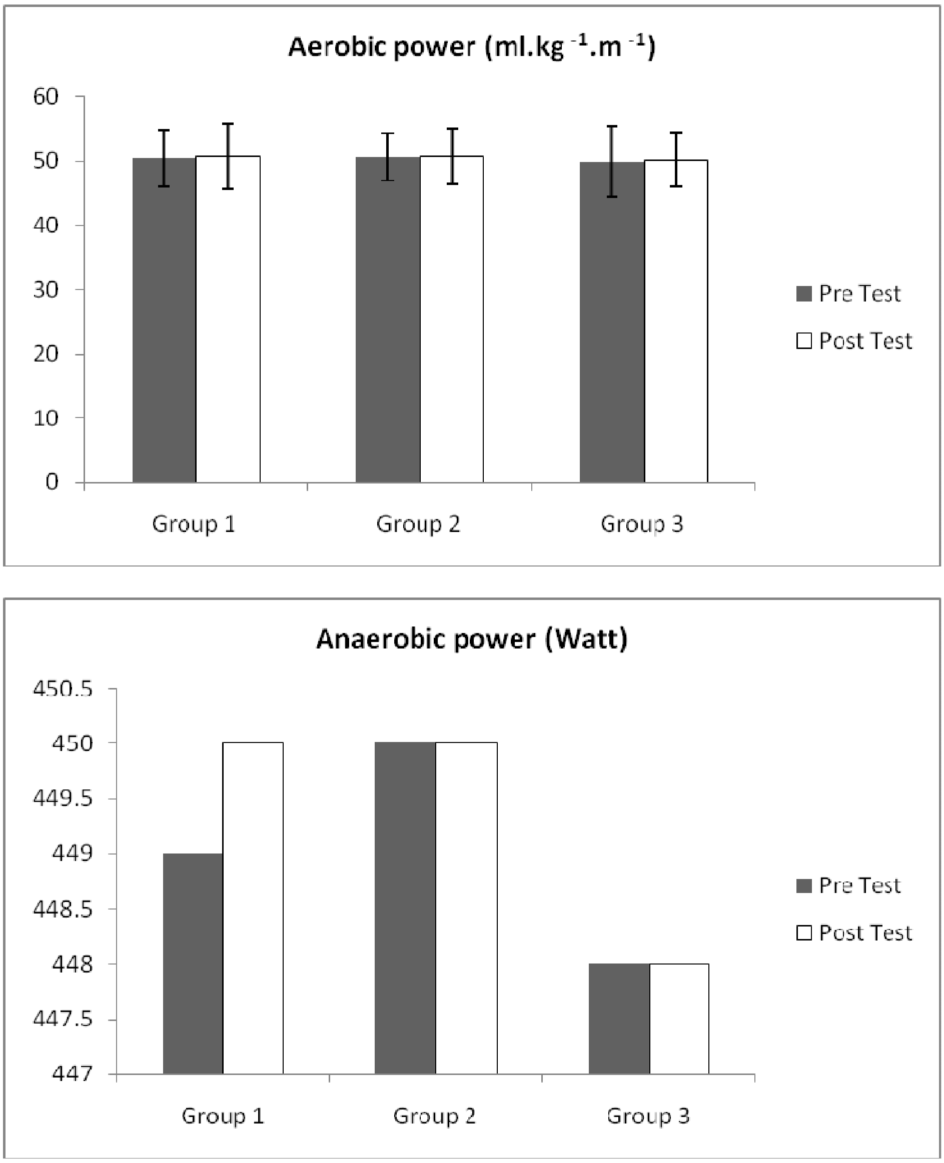

Figure1.Work measures before and after supplementation.

Data are means ±SD; Group1=500mg Vitamin C supplemented; Group2=1000mg Vitamin C supplemented; Group3=Placebo Group.

The results of this study indicate that supplementation with 500 and 1000 mg of vitamin C has not a significant effect on the aerobic capacity of male students. This study also found that using 500 and 1000 mg of vitamin C has not a significant effect on anaerobic capacity of male students during a 3-week period of ingestion. Jourkesh et al. [5] showed that 3 weeks of vitamin C supplementation (1000 mg/day in the form of ascorbic acid) offers a significant effect on aerobic capacity of male athletes. It seems that the significant increase in aerobic capacity of male athletes can be attributed to vitamin C, which leads to an increase of aerobic capacity in male athletes (1 ml/kg/min during the second and third week as compared with pretest results).

Some authors assume that higher doses of antioxidant vitamins may cause of greater changes in aerobic capacity [26]. A review of scientific literature indicates the lack of influence of antioxidant vitamins on work capacity [27, 28]. Since ascorbate in high concentrations may reduce NADPH and therefore provide the high-energy electrons necessary for aerobic metabolism [29], we were unable to show significant increase in subjects aerobic and anaerobic power. 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 [30].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 [31]. In support results of our study, Nieman ***et** al.* [32] found no beneficial effects of vitamin C supplementation on markers of immune function following a *2.5* h run. Various studies have also demonstrated beneficial physiological effects of vitamin C supplementation in physically-active people. Jakeman & Maxwell [11] reported greater recovery of maximal voluntary contraction in subjects who consumed 400 mg vitamin C/d for 21 d. Kaminski & Boals [33] reported less calf soreness in subjects who consumed 3 g vitamin C for 3 d before and 4 d after strenuous calf exercise. Peters ***et** al.* [34] noted fewer cases of self-reported upper respiratory tract infection in runners who consumed 600 mg vitamin C/d for 3 weeks before a 42 km road race.

In the present research antioxidant vitamin C supplementation did not show a significant effect on performance either in 500 mg or following 1000 mg supplementation. Several studies have examined vitamin C intakes in athletes from a variety of sports [35,36, 37, 38]. The results from a 24-h dietary recall suggested wide variation among sports, with some indication of seasonal variation, but no consistent trends emerged [38]. Low intakes have been observed in male gymnasts and wrestlers [38], and also in female athletes [35]. In contrast to these findings, the results from another project indicated very little difference in 1- or 7-day vitamin C intakes among athletes from different sports, including wrestlers [38]. Lower intakes in some athletes may reflect dietary interventions directed at weight control in these athletes, as it has been demonstrated that vitamin C intakes are related to total energy intakes [39]. Therefore, the amount of vitamin C in the diets of most athletes appears to be sufficient, based on the recommended daily allowance. Another approach to measuring vitamin C status has been to examine the response of plasma or serum ascorbic acid concentrations to supplementation with varying doses of vitamin C. Claudio et al. [40] failed to find performance benefit in soccer players after vitamins C supplementation daily during the pre-competitive season. They also demonstrated that antioxidant vitamin C and E supplementation in soccer players may reduce lipid peroxidation and muscle damage during high intensity efforts [40].

On the other hand, no single study has detected whole body ergogenic effect of antioxidant vitamins supplementation on performance or fatigue onset process. Lawrence et al. [41], and Rokitzki et al. [37], did not find changes in lactate threshold in antioxidant vitamin supplemented cyclists and swimmers respectively. Similarly, Shephard et al. [42] didn't detect alterations on muscle strength nor maximal oxygen uptake [43].Our results agreed with the work of Thompson et al. [43] and indicates that vitamin C supplementation can bring modest benefit for elite soccer players even under strenuous training, since it attenuated lipid peroxidation and muscle CK leakage, but did not have a direct ergogenic effect on physical performance. The reasons why antioxidant vitamin supplementation could prevent fatigue in isolated muscle fibers, although it cannot act as an ergogenic aid in the whole body of athletes are not yet understood, and further studies are needed to clarify this issue [40].The reason for the conflicting results is not clear, however variations in the intensity and duration of the exercise tests, the dosage and duration of antioxidant vitamin administered, and the time delay between administration and the beginning of the test are all factors that may explain these discrepancies.Epidemiological data suggest that diets rich in antioxidants protect against diseases associated with free radical damage, including cancer, cardiovascular disease and diabetes. Although some equivocation remains in the extant literature regarding the beneficial effects of antioxidant vitamin supplementation on muscle damage, there is little evidence to support such a role. Since the potential for long-term harm does exist, the casual use of high doses of antioxidants by athletes and others should perhaps be curtailed [45]. Early observations also suggested that vitamin supplements with antioxidant properties, like vitamins C and E, could also prevent or ameliorate pre-eclampsia, but most large randomized clinical trials have failed to show any benefit. Vitamin C given orally, even at high doses, does not achieve sustained serum levels that might be required for effective antioxidant activity. This may explain the failure of the numerous clinical trials involving its use in pre-eclampsia, cancers, cardiovascular diseases, etc. Vitamin C supplementation to stave off pre-eclampsia, cancer and other diseases is a 'nutraceutical' industry-driven myth which should be abandoned. We do not dispute a role for oxidative stress in the pathophysiology of pre-eclampsia, nor the possibility of amelioration of the disease by an anti-oxidant given at the right time and in the correct dosage. We simply wish to make a case that the massive and expensive clinical trials of vitamins C and E should cease until further rigorous scientific research is undertaken [44].In conclusion it can be stated that supplementation with antioxidant vitamin C has not a positive effect on physical work capacity evaluated by cooper and RAST tests. For the future, researchers may want to consider a longer supplementation period or a larger sample size to be able to detect significant differences between the trained and untrained groups using the same protocol. Additionally, a study design entailing a crossover may allow for less variability since each subject would have the opportunity to fall under both treatments.

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