

Cordyceps Sinensis (CordyMax Cs-4) Supplementation Does Not Improve Endurance Exercise Performance

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It is purported that supplementation with *Cordyceps Sinensis* (CordyMax Cs-4) will improve oxidative capacity and endurance performance. The intent of this investigation was to examine the effects of CordyMax Cs-4 supplementation on $\text{VO}_{2\text{peak}}$, ventilatory threshold, and endurance performance in endurance-trained cyclists. Twenty-two male cyclists participated in 5 weeks of supplementation with CordyMax Cs-4 tablets (3 g/d). Training intensity was maintained by weekly documentation and reporting throughout the 5-week period. Subjects completed a $\text{VO}_{2\text{peak}}$ test and work-based time trial prior to and following the supplementation period. $\text{VO}_{2\text{peak}}$ was similar within and between placebo (PLA) and treatment (CS) groups prior to (59.9 ± 5.9 vs. 59.1 ± 5.4 ml/kg/min, respectively) and following (60.1 ± 5.5 vs. 57.1 ± 5.8 ml/kg/min, respectively) the supplementation period. Ventilatory threshold (VT) was measured at $72 \pm 10\%$ of $\text{VO}_{2\text{peak}}$ in P and T prior to supplementation and did not change in either group following the supplementation. PLA completed the time trial in 61.4 ± 2.4 min compared to 62.1 ± 4.0 min in T. Time trial measurements did not differ between groups, nor did they change in response to supplementation. It is concluded that 5 weeks of CordyMax Cs-4 supplementation has no effect on aerobic capacity or endurance exercise performance in endurance-trained male cyclists.

Key Words: ergogenic aid, cycling, time trial, $\text{VO}_{2\text{peak}}$, supplement

Introduction

In an attempt to extend physiological performance beyond the benefits of physical training alone, many individuals choose to consume various nutritional and herbal dietary supplements. The choices of herbal extracts and concoctions available to the consumer are exhaustive (2). Many claims are made about herbal supplements, some of which approach that of panacea. Unfortunately, the availability of peer reviewed, well-controlled trials examining herbal supplementation and exercise performance are extremely limited (2). In reality, much of the support provided for herbals and exercise is anecdotal and lacks scientific rigor.

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Cordyceps sinensis (Berk.) Sacc. (*C. sinensis*) is an herb that has been used for centuries as a health tonic in China. Although naturally occurring, *C. sinensis* is rare; however, the discovery of its chemical composition has made the production of a synthetic compound possible. The synthetic compound CordyMax Cs-4 was utilized for this investigation. A thorough description of the composition of this proprietary extract may be provided by the manufacturer (12). In addition to a long list of positive physiological effects, *C. sinensis* is said to reduce fatigue and enhance endurance performance (18). The herb gained popularity in the athletic arena when record setting performances were attributed to the inclusion of *C. sinensis* as part of the athletes' training regimen (13).

Animal research suggests that *C. sinensis* is a bioactive compound with the ability to alter metabolism (5, 7, 16). With regard to effects on humans, comprehensive reviews of *C. sinensis* literature by Zhu et al. (17, 18) reports that *C. sinensis* has been used to treat a variety of conditions such as lung, kidney, and cardiovascular dysfunction as well as for general strengthening of the body after prolonged illness or strenuous training.

Though claims are made regarding fatigue and endurance, the influence of CordyMax Cs-4 on exercise in humans is largely unknown. Several abstracts examining the effects of CordyMax Cs-4 in trained (11), untrained (3), and sedentary (14) populations have returned mixed results. To date, no peer-reviewed studies examining the ergogenic properties of CordyMax Cs-4 have been published. It was the intent of this investigation to examine the influence of 5 weeks of CordyMax Cs-4 intake on the oxygen uptake characteristics and endurance exercise performance of endurance-trained cyclists.

Method

Subjects

Twenty-two endurance-trained male cyclists from the local college population (CS = 10, PLA = 12) completed all supplementation and testing procedures (Table 1). Subjects were informed of the risks associated with participation in the study and signed an informed consent document approved by the Human Subjects Institutional Review Board prior to participation.

Table 1 Subject Characteristics

Variable	CS	PLA
Age (yrs)	25 ± 5	25 ± 3
Height (cm)	175 ± 12	176 ± 6
Weight (kg)	73 ± 8	69 ± 6
Pre VO _{2peak} (ml/kg/min)	59 ± 5	60 ± 6

Testing Schedule

The first visit to the lab involved assessment of subjects' physiological characteristics and $\text{VO}_{2\text{peak}}$ pretesting. At least 3 days after the initial $\text{VO}_{2\text{peak}}$ test, a familiarization time trial was performed. No sooner than 7 days following familiarization, the pre time trial was performed. Testing occurred at the same time of day for each of the subjects. Supplementation was initiated after the pre time trial and continued for 5 weeks. During this time, subjects maintained a training regimen similar to that prior to beginning the study. This was confirmed through daily training logs and weekly contact with study administrators. Immediately after the 5 weeks of supplementation, a post $\text{VO}_{2\text{peak}}$ test was performed, followed 7 days later by a post time trial.

Supplementation

Participants in CS ingested 3.15 g of CordyMax Cs-4 every day for 5 weeks (2 capsules 3 times/day). This amount was similar to previous reports and consistent with the manufacturer's instructions. Placebo followed a similar capsule ingestion protocol; however, the capsules contained maltodextrose. Further PLA supplements were given a color and odor to match that of the CordyMax Cs-4. The study was double-blinded, and supplement identities were not revealed until after data analyses were completed.

$\text{VO}_{2\text{peak}}$ Testing

To determine aerobic power, subjects performed a graded exercise test protocol to determine maximal oxygen consumption. All training and testing was performed on an electromagnetically braked cycle ergometer (Lode Excalibur, Lode, Groningen, The Netherlands). Subjects began testing by cycling at 150 W for 3 min, with resistance raised by 25 W each additional minute until $\text{VO}_{2\text{peak}}$ was achieved. Three criteria were used to determine $\text{VO}_{2\text{peak}}$: reported rate of perceived exertion (RPE) of 20, respiratory exchange ratio (RER) > 1.5, and a plateau in $\text{VO}_{2\text{peak}}$ readings. Expired volume was determined by a Fleish pneumotach, and FEO_2 and FECO_2 were analyzed by a mass spectrometer. Oxygen uptake (VO_2) and carbon dioxide production (VCO_2) were calculated every 15 s by an online computer program. The mass spectrometer was calibrated prior to testing using certified medical gases of known concentration. Heart rate was monitored continuously by radiotelemetry and recorded at the end of each stage along with RPE. Ventilatory threshold (VT) was determined from a nonlinear increase in VE during the incremental test.

Endurance Time Trial Testing

Maximum power output (W_{max}) was calculated from the results of the $\text{VO}_{2\text{peak}}$ pretest. W_{max} was used to determine the target workload that was used in the endurance time trials and was based on the following modified formula of Jeukendrup et al. (8). Following Jeukendrup's approach (8), each subject performed three endurance time trials: a familiarization, and a pre and post endurance time trial. The familiarization trial followed the $\text{VO}_{2\text{peak}}$ pretest by 3 days and preceded endurance pretesting by 7 days. The time trial was equivalent to a calculated cumulative amount of work if the subject cycled at 75% W_{max} for 1 hour. Subjects were given a specific amount of

work (Joules) and instructed to complete the work as fast as possible. The cumulative work was calculated from the following formula (8):

$$\text{Target workload (J)} = 0.75 \times W_{\text{max}} \times 3600 \text{ s}$$

Subjects were informed as to the amount of work accumulated but were blinded to time and heart rate. RPE, RER, HR, and $\text{VO}_{2\text{peak}}$ were collected every 15 min and immediately prior to test termination. The same individual target workloads were used for each trial. Elapsed time to complete the target workload was the measure of performance. To ensure similar carbohydrate intake and muscle glycogen levels, subjects kept a detailed 24-hour dietary record prior to their first time trial. This diet was duplicated for the next time trial test. During time trial testing, subjects were allowed to consume water ad libitum.

Data Analysis

The study was a 2×1 factorial design, with three dependent variables. The treatment factor was nutritional supplement (CS vs. PLA), with the dependent variables being Change in $\text{VO}_{2\text{peak}}$, Ventilatory Threshold, and Time Trial. Independent t tests were applied to pretest values of all dependent variables to determine homogeneity between groups. Change in $\text{VO}_{2\text{peak}}$, ventilatory threshold, and time trial data were analyzed for each condition using three one-factor ANCOVAs, with the covariate being the absolute pre value for the respective dependent variable. Accumulated training time was evaluated with an independent t test. The level of significance was set at $p < .05$. All values are reported as mean \pm standard deviation.

Results

Time Trial Performance

Prior to supplementation, elapsed time to complete assigned workloads was comparable for the groups at 62.09 ± 4.03 min for CS and 61.42 ± 2.43 min for PLA (Table 2). Post time trials required 63.99 ± 6.16 and 60.80 ± 2.61 min for CS and PLA, respectively. Post values did not differ from pre values or between groups.

$\text{VO}_{2\text{peak}}$ and Ventilatory Threshold

Pretest VO_2 values were similar between groups (59.0 ± 5.4 vs. 59.9 ± 5.6 , CS and PLA, respectively) and did not change following 5 weeks of supplementation (Table

Table 2 Endurance Time Trial (min)

Variable	Pre	Post
CS	62.09 ± 4.03	63.99 ± 6.16
PLA	61.42 ± 2.43	60.80 ± 2.61

Table 3 $\text{VO}_{2\text{peak}}$ and Ventilatory Threshold

Variable	Pre	Post
$\text{VO}_{2\text{peak}}$ (ml/kg/min)		
CS	59.0 ± 5.4	57.0 ± 5.8
PLA	59.9 ± 5.6	60.1 ± 5.5
Ventilatory Threshold (% $\text{VO}_{2\text{peak}}$)		
CS	72 ± 11	70 ± 9
PLA	72 ± 10	69 ± 13

3). Likewise beginning ventilatory threshold values did not differ between groups and was unaffected by the CordyMax Cs-4 intervention.

Training Volume

Assessment of weekly training logs showed the average training hours to be similar between the groups. Training time over the 5 weeks was 36 ± 12 hours for CS and 37 ± 13 hours for PLA.

Discussion

Though numerous claims are made regarding the ergogenic properties of nutritional supplements, in many cases the claims lack scientific support (2). This is the first published, double-blind, placebo-controlled study to examine the effects of CordyMax Cs-4 supplementation (5 weeks) in an endurance-trained population. In the current subjects, CordyMax Cs-4 intake did not improve oxygen uptake or endurance exercise performance.

C. sinensis is an herb used for centuries as a health tonic in China. It is found in remote areas of Tibet and southwestern China. The creation of an artificially fermentable strain of *C. sinensis* has supported the production and marketing of this herbal supplement on a large scale. *C. sinensis* has been shown to be safe for human consumption, with only minor side effects. The suggested benefits of *C. sinensis* ingestions are so far ranging that the herb may be described as a panacea (17, 18).

To date, the effects of CordyMax Cs-4 on exercise performance have been presented only in abstract form. In an endurance-trained population, $\text{VO}_{2\text{peak}}$ and ventilatory threshold increased in both the supplemented and control groups after 6 weeks of supplementation; however, there were no differences between the groups (11). A 4-week intervention in male subjects returned no change in $\text{VO}_{2\text{max}}$ following supplementation for the supplemented or placebo groups (3). Further, there were no differences between the groups. In two other studies utilizing elderly (15) and sedentary (14) subjects, small improvements in $\text{VO}_{2\text{max}}$ and endurance perfor-

mance were realized following 6 and 12 weeks of CordyMax Cs-4 supplementation, respectively. At present, no detailed, peer-reviewed manuscripts are available for these investigations.

C. sinensis has been shown to have chronotropic effects (4) on the heart as well as a general blood pressure lowering effect (9) in the peripheral circulation. Furthermore, animal studies suggest an effect on hepatic energy balance (5, 6, 10), though data regarding skeletal muscle metabolism are not available. Though these systems are related to blood flow and oxygen uptake, it is likely that these reported physiological actions would have little influence on aerobic capacity. In the present subjects, $\text{VO}_{2\text{peak}}$ and ventilatory threshold remained unchanged in CS and PLA following the supplementation period. These findings suggest that if *C. sinensis* did influence cardiovascular and metabolic systems, these effects did not contribute to oxygen uptake and aerobic capacity.

The responses of glucose abnormalities and lipid metabolism following *C. sinensis* intake have been examined (18). *C. sinensis* appears to lower plasma triglycerides as well as cholesterol, although the direct mechanism is unclear. Interestingly, acute *C. sinensis* supplementation has a persistent hypoglycemic effect in animals (17). In contrast, prolonged supplementation appears to maintain whole-body glucose disposal in rodents (1). Though these studies clearly demonstrate the bioactivity of *C. sinensis*, neither would appear to possess acute ergogenic effects for endurance performance. To the contrary, the effects on blood glucose could be considered ergolytic for prolonged exercise performance. In spite of these metabolic effects, the endurance time trial performance of the current subjects did not change after 5 weeks of CordyMax Cs-4 ingestion. It should be noted that large dosage discrepancies exist between animal and human studies, and this must be considered when evaluating reports regarding physiological responses in humans and animals.

Despite the broad range of effects reported regarding the effects of *C. sinensis* supplementation, little data is available to pinpoint the mechanism of this herb. Claims reporting positive physiological and performance effects of *C. sinensis* are unsupported by the present study. In the current subjects, CordyMax Cs-4 supplementation (5 weeks) failed to elevate aerobic capacity or enhance endurance exercise performance. Future studies involving the specific mechanisms of CordyMax Cs-4 may provide insight into effective prescriptions of this herbal supplement.

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