SUPPLEMENTAL ANTI–FATIGUE EFFECTS OF CORDYCEPS SINENSIS (TOCHU–KASO) EXTRACT POWDER DURING THREE STEPWISE EXERCISE OF HUMAN

AKIRA NAGATA1), TAEKO TAJIMA3) and MASAYUKI UCHIDA2)

Abstract

The purpose of this study was to examine the effectiveness of the cultured Cordyceps sinensis (Cs, supplement powder) during exhaustive running of human comparing with the placebo (control). These supplements were given to 36 male sedentary subjects over period of 2 weeks. During the exercise, following bio–signals were measured such as respiratory variables (VO2, VCO2, VE), the blood presure (BP), the heart rate (HR), and the lacta acid (LA). In addition, their storing urine for one night was inspected about the cateholamine (CA, Adr, NorA, Dop) and the cortisol hormone (17–KA–S and 17–OHCS) at the pre–and the post–ingesting with those supplements. The changing ratio calculating between the pre– and the post–variables of VO2/kg (5.2 ± 0.1 g & 4.8 ± 0.1 ml), VE (12.0 ± 0.2 L & 11.0 ± 0.2 L), and LA (6.1 ± 2.1 & 5.2 ± 2.6 mmol/dl) had decreased to lower percentages at the recovery period from the exercise test than those of CON, significantly (p < 0.01). Furthermore, concentration of the total CA (1.19 ± 0.51 & 1.29 ± 0.49 mg/L), Adr (13.5 ± 1.2 & 17.7 ± 1.9 μg/L), NorA (127.4 ± 8.1 & 130.0 ± 8.3 μg/L), Dop (1.06 ± 0.1 & 1.14 ± 0.4mg/L), 17–OHCS/creatinine (4.42 ± 0.30 & 4.2 ± 0.31), and 17–KS–G/creatinine (3.18 ± 0.09 & 3.06 ± 0.07) showed changes of significant difference related to the placebo (p < 0.05). There have been appeared an augmentation of the energy generation and the anti–fatigue ability intaking with this supplement during the exercise test. During this protracted exercise, ingesting with this Cs might elicit the superior efficiency and the economical function on the energy metabolism.


key word: Cordyceps sinensis, expired gas, prolonged exercise, cateholamine, cortisol

Introduction

Cordyceps sinensis (Berkeley) Saccard (Cs) is a parasitic fungus whose host is a larva of Hepialus armoricanus Oberthür, a Lepidoptera moth. The fruit bodies of Cs together with the larva have been used in the traditional medicine of China for a long time. The Cs has been considered to have such superior function as the anti–aging. In order to demonstrate effectiveness of Cs to the anti–fatigue, recently a few studies of animal experiments5–7) have been reported on the fields of the pharmacology. However, those experiments have only shown about pharmacetics effects of this Cs on the experimental animal. Then it is necessary to check that performance of the anti–fatigue would have increased during the prolonged exercise of human after the ingestion with this supplement, quantitatively. The paper of Hiyoishi et al.11) have suggested that the intake of the cultured Cs have increased the physiological performance and the potential action during running of the athletes. The purpose of this study was to examine effectiveness of this Cs upon their performance during exhaustive running of human. We expect for this Cs as a supplemental stimulant to enhance the energy efficiency and the endurance ability upon measurements of the adrenal hormone in the urine and the cardiovascular–respiratory variables during exercise test.

Methods

Thirty–six healthy men, from whom we had

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Table 1. Average characteristic of subjects.

<table>
<thead>
<tr>
<th>Item</th>
<th>AG</th>
<th>CG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>26.7yr</td>
<td>28.5yr</td>
</tr>
<tr>
<td>Height</td>
<td>168.6cm</td>
<td>171.1cm</td>
</tr>
<tr>
<td>Body Weight</td>
<td>65.3kg</td>
<td>70.7kg</td>
</tr>
<tr>
<td>Systolic Blood Pressure</td>
<td>117.9mmHg</td>
<td>120.5mmHg</td>
</tr>
<tr>
<td>Diastolic Blood Pressure</td>
<td>68.5 mmHg</td>
<td>73.0 mmHg</td>
</tr>
<tr>
<td>Body Mass Index (BMI)</td>
<td>22.9</td>
<td>24.2</td>
</tr>
</tbody>
</table>

Table 2. Content of two test powders of *Cordyceps sinensis* (ACT) and Placebo (CON) supplements.

<table>
<thead>
<tr>
<th></th>
<th>Supplement (g)</th>
<th>Placebo (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cordyceps Sinensis</em> extract</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Dextrin</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>Apple Flavor</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.955</td>
<td>0.955</td>
</tr>
<tr>
<td>Total Sum</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

obtained their informed consent, were classified in two groups of ACT with this Cs and CON with the placebo. Their characteristics are shown in Table 1. Two kinds of the powder materials of 240mg content were given to them for two weeks starting in Autumn of 2003. Five materials of the Cs (0.5g), the glucose (0.96g), the apple flavor (0.02g), and the citric acid (0.025g) were dissolved in 1000ml

I. Exercise Stress Tests at the Pre- and the Post-ingestion

Three stepwise of 40%, 60% and 80% maximum Heart Rate (HRmax)

II. Data Sampling at Elapsed Time

- Sampling Data of Expired Gas (VO$_2$/kg, VCO$_2$/min, VE) & Heart Rate
- Inspecting Lactic Acid, Blood Pressure & Urine (catecholamine & cortisol) before and after ingestion

Fig. 1. Protocol of the exercise stress tests with three stepwise method(I) and the sampling scheme of the cardio vascular–respiratory variables & the inspection of the hormone data in the storing urine( II)
Fig. 2. Changes of the oxygen uptake (\(\dot{V}O_2/\text{kg}\)) at elapsed time during the prolonged exercise (upper) and the changing ratio between those values of the pre- and the post-ingestion with two supplements (lower).

Fig. 3. Changes of the ventilatory volume (\(\dot{V}E\)) during the exercise stress test at elapsed time (upper) and the changing ratio between those values of the pre- and the post-ingestion with two supplements (lower).
water. While, in the placebo powder, only the dextin (0.5 g) was used instead of this real Cs. These contents of two supplements are displayed at Table 2. Before and after this ingesting period, they practiced twice the running tests using the treadmill for nine minutes on three stepwise methods of 40% (Ex1), 60% (Ex2), 80% (Ex3) of maximum Heart Rate (HRmax). During these exercises, the oxygen uptake (VO2) the carbon dioxide output (VCO2) the ventilatory volume (VE), the blood pressure (BP), the heart rate (HR), and the lactic acid (LA) were measured on elapsed time. Their storing urine for one night before these tests were sampled to inspect about the catecholamine (CA, Ad, NorA, Dop) and the cortisol hormone (17-KS-S, 17-KS-G and 17-OHCS) and the creatinine at the pre- and the post-

![Graph](image)

Fig. 4. Concentrative histogram and the changing ratio of the lactic acid at the rest, during the exercise, and at the recovery time related to the pre- and the post-ingestion with those supplements of the Cs & the placebo.
ingestion with those supplements. Those experimental protocols are shown at Fig. 1.

Results

Before and after ingestion with two supplements (ACT & CON), these experimental results are shown at Fig. 2(\(\bar{V}O_2/\text{kg}\)) Fig. 3(\(\bar{V}E\)), Fig. 4(lactic acid), Fig. 5(catecholamine) and Fig. 6(cortisol hormone). Those respiratory variables and LA at the pre- and the post- ingestion of ACT group have been showed at the significant lower levels of \(\bar{V}O_2/\text{kg}(5.2\pm0.1 \text{ & } 4.8\pm0.1 \text{ ml})\), \(\bar{V}E(12.0\pm0.2 \text{ & } 11.0\pm0.2 \text{ L})\) and LA(6.1±2.1 & 5.2±2.6 mmol/dL). These changing ratio of ACT group have de-

![Graphs showing changes in catecholamines and noradrenaline](image)

Fig. 5. Concentratative changes and the changing ratio of catecholamine(adrenaline, noradrenaline, and dopamine) in their storing urine for one night at the pre- and the post- ingestion with these supplements of the Cs & the placebo.
increased to lower values than those of CON during the first exercise of 40% HRmax (Ex1) and at the recovery times (Rec 1 & Rec 3) significantly (p < 0.05). Otherwise, values of the systolic blood pressure and the heart rate have been displayed little changes at the post time after ingestion with this supplement (p > 0.05). Before and after ingestion with this Cs, the urine concentration and the changing ratio of the catecholamine (1.19 ± 0.51 & 1.29 ± 0.49 mg/L), the adrenaline (13.5 ± 1.2 & 17.7 ± 1.9 μg/L), the noradrenaline (127.4 ± 8.1 & 130.0 ± 8.5 μg/L), the dopamine (1.06 ± 0.1 & 1.14 ± 0.4 mg/L), 17-OHCS/creatinine (4.42 ± 0.30 & 4.2 ± 0.31), and 17-KS-S/17-OHCS (3.18 ± 0.09 & 3.06 ± 0.07) were obtained significant difference comparing with ingestion of the placebo (CON; p < 0.05).
Discussion/Conclusion

Previously, Hiyoshi and Nagata had indicated an increasing performance in the whole endurance of human. In the other study, the mice giving the same supplement were able to swim for longer time than the control animal. Respiratory variables after this ingestion have decreased at the first exercise of 40% HRmax and at the recovery time from those exercise test. These decreasing results should indicate the more efficient energy metabolism to perform these running. Those results should have been thought to be coincide with results of the other study that were obtained improved performance and the recovery ability from the whole fatigue. There have been appeared superior anti-fatigue ability and higher endurance performance associated with this Cs supplement. Additionally, the decreasing concentration of the lactic acid would demonstrate the promotion of utilizing the oxygen in TCA cycle. Then, ACT groups may have received much more stimulant to the anti-fatigue function than those of CON at the recovery time. The intake of this supplement might inhibit some production of the radicalsuperoxide associated with increasing the energy generation, and this should be due to a suppression in the use of glucose nutrition. Then, we concluded that this Cs supplement should increase the efficiency of ATP generation in the metabolic process of the mitochondria cell, and that these effects might be relative to a little decrease of the oxygen and the nutrition consumption, and to the increase of the transporting function of 2, 3-diphosphoglycerate (DPG) reported in the previous study.

The decreasing values of 17-KS-S/creatinine and 17-OHCS/creatinine might indicate the much lower stimulant during this exercise test with ingesting this Cs, and then their mental fatigue should be attenuated during this exercise. These concentrations of those hormone might indicate a decreasing stress to the adrenal cortex. While, those increasing difference of the catecholamine concentration between the pre- and the post-ingestion suggest that the action of the secretory function of the adrenal medulla might appear the more facilitating and the more exciting of the sympathetic nervous system being necessary during the prolonged exercise than the ingesting effectiveness of Cs supplement for two weeks.

Reference