Effects of Astaxanthin Ingestion on Exercise-Induced Physiological Changes

Abstract

The purpose of this study was to evaluate the effects of astaxantin (ACT) ingestion on exercise-induced physiological functions. In this experiment we planned to investigate the autonomic nervous system (ANS) and the respiratory metabolism during different exercise intensities in subjects taking astaxantin and those taking placebo. The design of this experiment was a double-blind crossover study.

Eighteen male volunteers (35.8 $\pm$ 4.51 years of age) took ACT or placebo (CON) capsule daily for two weeks. Exercise stress tests were done before and after the ingestion period. The exercise load was in the form of running exercise on a treadmill at intensities of 30%, 50% and 70% of maximum heart rate (HRmax). Heart rate variability (HRV), expired gases analysis and blood biochemical parameters were measured. Sympathetic nervous activity (SNA) and parasympathetic nervous activity (PNA) were estimated from the pattern of power density in three frequency ranges on the power spectrum.

During the exercise at an intensity of 70% HRmax, CV_{RR} and HF/TF increased significantly (p<0.05) after ACT ingestion. Additionally, V_E decreased significantly (p<0.05) during exercise at 70% HRmax after ACT ingestion. These data indicated that after ACT ingestion, SNA was decreased and PNA was enhanced during exercises at 70% HRmax. Furthermore LDL cholesterol decreased markedly after exercise (p<0.05) and respiratory quotient decreased during exercise. These results suggest that ACT may contribute to enhancement of lipid metabolism. Decrease of respiratory parameters may indicate augmentation of the efficacy of exercise in energy metabolism.

II. Study Design

1) Subjects

18 healthy subjects have been chosen by a medical examination prior to the testing. The backgrounds of the subjects include the following. Average age: 35.7±4.4 years, average

weight: 69.0±9.2kg, average height: 170.6±3.8cm, average resting heart rate: 75.9±14.4bpm, and average total cholesterol: 198±35.4mg/dl. In addition, this research was approved by the Logical committee of Biomedical Sciences that subjects the people inside the organization. Agreements of candidates for subject were obtained after the committee's approval, and the research was started.

2) Procedure

Subjects were divided into two groups those taking astaxanthin (5mg) and those taking placebo. The design of this experiment was a double-blind study, and capsules were used. ACT was set as active capsules ingestion group, and placebo was set as control capsules ingestion group. Both groups took capsules daily for two weeks. Exercise stress tests were done before and after ingestion period. After the first stage of exercise stress load and 1 month wash-out period, groups were cross-over and done the second stage.

3) Exercise Stress Tests

As shown in Figure 1, the intensities of 30%HRmax, 50% HRmax, and 70% HRmax of running exercise on a treadmill were set respectively to subjects, after their rest heart rate were measured. For experimental protocol: each subject was given with rest, warm-up, and three stepwise running exercise on treadmill for 3 minutes respectively, followed by 4 minutes cool-down and 7 minutes recovery time. During the protocol, electrocardiography and expired gases were measured, and blood was sampled from median cubital vein two times.

4) Measuring Items and Analysis

(1) Items of Expired Gases Analysis: ventilator exchange volume (V_E), oxygen uptake per body weight (VO_2), and carbon dioxide output (VCO_2) were collected and analyzed by Breath by Breath method with expired gases analysis system (RD17MX).

(2) Blood Pressure and Heart Rate: Maximum blood pressure (SBP) and minimum blood pressure (DBP) were measured during rest, immediately after exercise, and recovery time.

(3) Heart Rate Variability: Electrocardiography was measured by CM5 Precordial Leads method and frequency analysis of coefficient of variance of R-R intervals was done by MemCalc method. Component between 0.03Hz and 0.4Hz of power spectrum density was set as total frequency band power

density (TF), 0.03Hz-0.15Hz as low frequency band power density (LF), and 0.15Hz-0.4Hz was set as high frequency band power density (HF). LF/HF ratio found from each component was used as the indicator of sympathetic nervous system acceleration. Also, coefficient of variance of R-R intervals (CV_{RR}) was found as time domain component, and used to evaluate the balance of autonomic nervous system.

(4) Blood Test: Total cholesterol (T-CHO), LDL and HDL cholesterol, Glucose, Catecholamin (CA) (Adrenaline, Noradrenalin, Dopamine) were collected from median cubital vein 10 minutes before and immediately after exercise, then stored at low temperature, and analyzed.

Average value of each data and change ratio immediately after ingestion were found, and Tukey's method was used for testing significant differences. Significance level was set as less than 0.05.