

ANTIOXIDANT STATUS OF U.S. BIATHLETES DURING ALTITUDE TRAINING

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Abstract

The goal of this study was to assess antioxidant status during a 10-day cross-country skiing training camp. Participants included four U.S. Biathlon Team members (3 male, 1 female, age=23 yr, VO₂max=70.4 ml/kg/min male, 54 ml/kg/min female). Training took place at 2,100 m and consisted of 2-4 hours per day of cross-country skiing at approximately 60-70% VO₂max. Blood samples for the determination of retinol, beta-carotene, alpha-tocopherol, gamma-tocopherol as well as the ratio of reduced glutathione (GSH) to oxidized glutathione (GSSG) were measured before and after exercise on days 1 and 10. Plasma vitamin measures were determined by HPLC analysis and the GSH/GSSG was determined colorimetrically by OXIS Research, Portland OR. A comparison between the athletes' vitamin status and published normative values indicated that all athletes were within normal ranges on both days 1 and 10 for all antioxidant vitamins measured. A decrease in the GSH/GSSG ratio is a sensitive marker of oxidative stress and indicates a decrease in the reductive capacity of the red blood cell. On day 10, the post-exercise GSH/GSSG ratio (153:1) was significantly lower than the pre-exercise value (241:1, p=.016). Also, the GSH/GSSG ratio following exercise on day 10 (153:1) was lower than the post-exercise value on day 1 (202:1, p=.06). These data indicate a change in redox status after a training bout and over 10 days of aerobic training at altitude. Although antioxidant vitamin status was normal throughout the training camp, the redox status was shifted toward an oxidative state. Oxidative stress is often regarded as a negative consequence of training, however, it is possible that it may provide a stimulus for physiological adaptation.

Introduction

The increase in energy expenditure and oxygen consumption during exercise has been associated with an increase in the production of reactive oxygen species. These free radicals can be damaging to lipid membranes, bioenergetic enzymes, structural proteins and DNA. Oxidative damage to these structures may lead to impaired oxygen carrying capacity of erythrocytes, muscle damage, decreased ATP production, and cellular mutations. It has therefore been suggested that athletes consume a diet rich in antioxidants to prevent high levels of oxidative stress during training and competition. The goal of this study was to assess the change in plasma antioxidant status and reductive capacity of red blood cells in endurance athletes during aerobic training at altitude.

Methods

Participants included four members of the U.S. Biathlon Team (3 male, 1 female, age=23 yr, VO₂max=70.4 ml/kg/min male, 54 ml/kg/min female). Blood samples were drawn from an antecubital vein prior to and immediately following exercise on Days 1 and 10 of a 10-day training camp at 2,100m. Training consisted of 2-4 hours per day at approximately 60-70% VO₂max. Blood samples were sent to OXIS Health Products, Inc. (Portland, Oregon) for assays of antioxidant status. Six measures of antioxidant status were determined using colorimetric and HPLC methods: 1) α-tocopherol, 2) γ-tocopherol 3) β-carotene and 4) Retinol were used to assess antioxidant vitamin status. 5) Reduced glutathione (GSH) and 6) oxidized glutathione (GSSG) were assayed as indicators of endogenous antioxidant status. The ratio of GSH/GSSG was used as a sensitive marker of change in erythrocyte redox status. Suspected differences over time were compared using paired t-tests (α = .05).

Results

Results indicate that there are no significant changes in plasma antioxidant vitamin levels immediately following aerobic exercise and over 10 days of aerobic training (Table 1.). On day-10, the GSH/GSSG ratio decreased significantly (p=0.016) from pre-exercise to post-exercise. Also, the decrease in GSH/GSSG from post-exercise on day 1 to post-exercise on day 10 approached statistical significance (p=0.06).

Table 1. Antioxidant status (Mean ± S.D.)

Measure	PRE-Day 1	POST-Day 1	PRE-Day 10	POST-Day 10
α-tocopherol (mg/L)	9.69 ± 1.70	9.61 ± 1.64	12.32 ± 2.17	12.19 ± 1.92
γ-tocopherol (mg/L)	1.35 ± 0.45	1.17 ± 0.30	1.89 ± 0.61	1.58 ± 0.47
β-carotene (mg/L)	0.35 ± 0.27	0.34 ± 0.25	0.45 ± 0.32	0.39 ± 0.32
Retinol (mg/L)	0.79 ± 0.14	0.79 ± 0.12	0.95 ± 0.19	0.91 ± 0.20
GSH (nmol/mg Hb)	874.3 ± 81.5	833.5 ± 112.9	950.8 ± 106.6	966.5 ± 73.6
GSSH (nmol/mg Hb)	3.66 ± 1.32	4.15 ± 0.70	4.25 ± 1.70	6.65 ± 1.72
GSH/GSSG	264.2 ± 100.3	202.8 ± 29.9†	241.3 ± 69.8*	152.9 ± 46.6*†

* (p=.016)

† (p=.06)

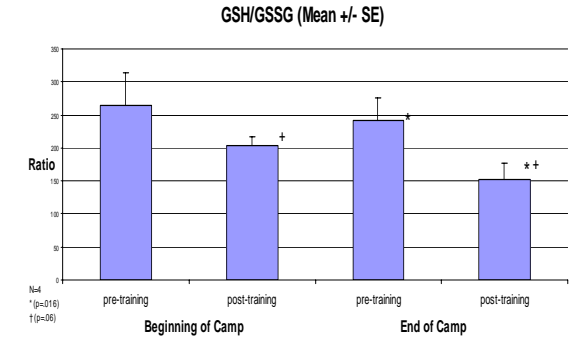


Figure 1. Glutathione ratio during 10-day training camp

Discussion

These data indicate a change in redox status after a training bout and over 10 days of aerobic training at altitude. Although antioxidant vitamin status was normal throughout the training camp, erythrocyte redox status was shifted toward an oxidative state immediately following exercise and throughout the training camp (Figure 1). GSH appeared to increase from day 1 to day 10 representing an upregulation in the antioxidant capacity of the erythrocyte. However, the oxidation of glutathione (GSSG) increased at a faster rate. A decreased GSH/GSSG ratio indicates a decrease in the reductive capacity of the erythrocyte and an increase in oxidative stress, possibly leading to cell damage. Oxidative stress is often regarded as a negative consequence of training, however, it is used as a cellular signaling mechanism and it may provide a stimulus for physiological adaptation. Therefore, the administration of high doses of antioxidant vitamins to athletes should be questioned.

References

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