TIME AND DAY EFFECT ON GROSS EFFICIENCY WITH QUERCETIN SUPPLEMENTATION

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Abstract

The purpose of this study was to examine the effects of 3 hr intensive cycling over 3 successive days on cycling economy (CE) and gross efficiency (GE) under quercetin and placebo supplementation conditions. Forty trained cyclists were randomized into quercetin and placebo groups and tested for VO_{2max} (53.2±1.2, and 54.7±1.1 $ml*kg^{-1}*min^{-1}$). For 3 weeks following VO_{2max} testing, subjects supplemented with either 1000 mg/day quercetin or placebo. Following the initial 3 week supplementation period, subjects then cycled at 57% $watts_{max}$ for 3 hr using their own bicycles on CompuTrainer™ Pro Model 8001 trainers (RacerMate, Seattle, WA) on 3 successive days. Metabolic measurements were taken every 30 minutes using the MedGraphics CPX metabolic system (St. Paul, MN) for each 3 hr ride. Muscle glycogen levels were obtained from muscle biopsies taken from the vastus lateralis immediately pre- and post-exercise on days 1 and 3. There was no quercetin treatment effect for any of the outcome measures in this study. Power output remained constant for all three exercise trials, but significant decreases over time were measured for CE, GE, cadence, glucose, RER, and muscle glycogen, and significant increases were measured for heart rate, lactate, and VO_2 over time. Initial GE and CE were reduced on Day 2 compared to Day 1. These data indicate that CE and GE are reduced during an exhausting 3 hr bout of exercise, and this may carry over to the following day.

Methods

Research design: Forty trained male cyclists were recruited through local and collegiate cycling clubs. Two to three weeks prior to the first test session, subjects reported to the ASU Human Performance Lab for orientation and measurement of body composition and cardiorespiratory fitness. VO_{2max} was determined using a graded maximal protocol (25 watt increase every two minutes starting at 150 watts) with the subjects using their own bicycles on CompuTrainer™ Pro Model 8001 trainers (RacerMate, Seattle, WA). Maximum workload was extrapolated from the amount of time in the last stage. Basic demographic and training data were obtained through a questionnaire. During orientation, a dietitian instructed the subjects to follow a diet moderate in carbohydrate during the three days prior to and during the 3-day test sessions, and record intake in a food record.

The cyclists were randomized to quercetin (N=20) or placebo (N=20) groups and under double blind procedures received three weeks quercetin (1000 mg/day) or placebo supplements prior to, during, and for two weeks after the three-day period of intensified exercise.

Subjects came to the lab for three consecutive days following the 3-week quercetin or placebo supplementation period and cycled for 3 hr at ~57% $Watts_{max}$. Subjects reported to the lab at 2:00 pm not having ingested energy in any form after 12:30 pm. Muscle biopsies were collected from the vastus lateralis 15 min pre-ride and immediately post ride on the first and third day. Experimental subjects ingested water 15-30 min pre-exercise and during the 3 hr cycling bout. No other beverages or food were ingested during the test sessions.

During the test sessions, experimental subjects cycled using their own bicycles on CompuTrainer™ Pro Model 8001 trainers. Metabolic measurements were made every 30 minutes of cycling using the MedGraphics CPX metabolic system to verify workload. Current workload, average cadence, overall rating of perceived exertion (RPE) were also collected every 30 minutes. Fingertip capillary blood samples were drawn using heparin lined microcapillary tubes every hr during the ride for lactate and glucose. Since cadence can affect efficiency, subjects were encouraged to maintain the same cadence.

Muscle Glycogen Analysis: Muscle samples were homogenized in 0.3 M perchloric acid and glycogen digested by the amyloglucosidase method. The resulting glucose moieties were quantified spectrophotometrically (Genesys 5, Thermo Spectronic, Rochester, NY) in the presence of hexokinase and glucose-6-phosphate dehydrogenase.

Blood analysis: Blood samples taken during the rides were analyzed using a YSI 2300 STAT Plus Glucose and Lactate analyzer (Yellow Springs, OH).

Gross Efficiency and Cycling Economy: Gross efficiency (GE) during the 3 hr rides were calculated for each measuring period as the ratio of power output to power input expressed as a percentage. Power output was the amount of watts determined by the Computrainer following the manufacturer-recommended calibration, expressed in $kcals*min^{-1}$ (where 1 watt = 0.01433 $kcals*min^{-1}$). Power input was the rate of energy expenditure using indirect calorimetry. The rate of energy expenditure ($kcals*min^{-1}$) was calculated from VO_2 and RER using the formula of Lusk. Cycling economy (CE) was calculated solely from the ratio of wattage and VO_2 and expressed in ($watts*min*L^{-1}$).

Statistical Analysis: Data are presented as means + SEM. The effect of time and treatment was determined using a 2-way repeated measures ANOVA with Bonferroni post-hoc comparisons (SPSS version 11.5, Chicago, IL). Correlations were performed using a 2-tailed Pearson Product Correlation. Statistical significance was set at $p \leq 0.05$.

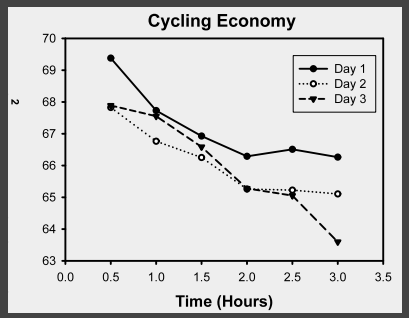
Introduction

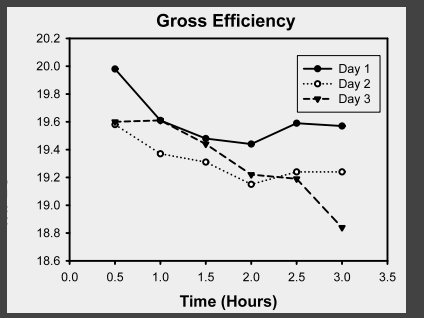
Gross efficiency is based on the relationship between VO_2 and power output measured during cycling. Efficiency does not appear to be significantly different between untrained and trained cyclists and has been reported to be inversely related to VO_2 max in elite cyclists. Body position, level or uphill riding and standing or sitting positions have all been shown to influence gross efficiency. However, changes in gross efficiency during long-duration cycling exercise or following successive bouts of exercise have not been studied. There have been investigations that have implied that prolonged cycling decreases gross efficiency, however cycling for longer than one hour has never been examined. Typically, VO_2 tends to increase slightly during prolonged cycling at a fixed exercise intensity (at intensities < 75% of VO_{2max}) due to increases in body temperature and epinephrine levels. This implies that gross efficiency would decrease.

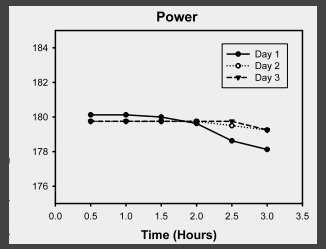
Recently there has been some evidence that the flavonoid quercetin is capable of stimulating mitochondrial biogenesis in mice. There is no evidence currently on the effects of quercetin on exercising humans.

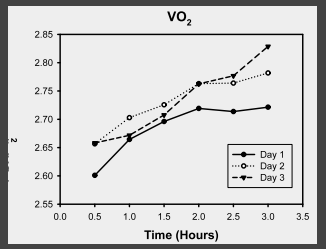
Therefore, the purpose of this study was to examine the effect of quercetin and three successive days of long duration cycling (3 hrs) on gross efficiency and cycling economy.

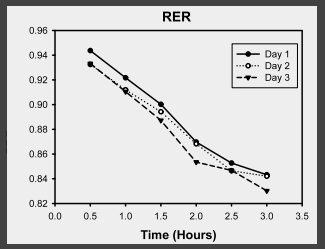
Results

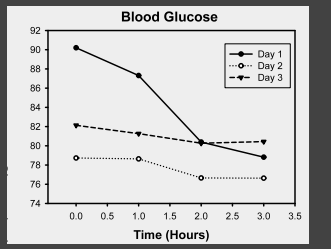












Subject Characteristics

Variable Mean±SE	Cyclists (N=20) Quercetin	Cyclists (N=20) Placebo
Age (yrs)	26.1±1.8	29.1±2.4
Weight (kg)	74.7±0.2	74.2±1.4
Body fat (%)	13.8±1.2	11.5±0.6
Train Distance (km/wk)	242±27	270±29
VO_{2max} (ml/kg/min)	53.2±1.2	54.7±1.1
$Power_{max}$ (watts)	314±9	320±69
HR_{max} (beats/min)	188±1	190±2

Conclusions

Both Cycling Efficiency and Gross Economy were found to decrease significantly during each of the 3 successive days of 3 hr bouts of cycling at ~57% max. A significant decrease in cadence, glucose, RER and muscle glycogen levels were found along with a significant increases in HR, lactate and VO_2 during each 3 hr bout. A significant day effect was found for GE and CE from day 1 to day 2 indicating that GE and CE could be diminished during successive days of prolonged cycling. Quercetin supplementation did not cause any significant changes in GE, CE, HR, lactate, RER, glucose, cadence, VO_2, or muscle glycogen levels.