Sports drinks, Caffeine, alcohol and their effect on exercise

Wednesday April 4th, 2007

Upcoming events

• Brick workout
  – on Saturdays April 7th - 9 am swim/workout
  – Saturday April 14th - 9am? choice
  – Saturday April 21st (maybe Sunday April 22nd) mini-triathlon

• Wednesday April 18th 3:30 pm be at the International Bike Center on 89 Brighton Ave
  – We will see a bike being assembled
  – Who needs a ride?
Sports Drinks

• Gatorade
  – look at the history of the drink:
    http://www.gatorade.com/history/born_in_the_lab/
• POWERade
• Accelerade
• ENDUROX
• HammerGel series

B vitamins


From the paper's abstract:

"Biotin has stimulatory effects on genes whose action favors hypoglycemia (insulin, insulin receptor, pancreatic and hepatic glucokinase); on the contrary, biotin decreases the expression of hepatic phosphoenolpyruvate carboxykinase, a key gluconeogenic enzyme that stimulates glucose production by the liver. The findings that biotin regulates the expression of genes that are critical in the regulation of intermediary metabolism are in agreement with several observations that indicate that biotin supply is involved in glucose and lipid homeostasis. Biotin deficiency has been linked to impaired glucose tolerance and decreased utilization of glucose. On the other hand, the diabetic state appears to be ameliorated by pharmacological doses of biotin. Likewise, pharmacological doses of biotin appear to decrease plasma lipid concentrations and modify lipid metabolism. The effects of biotin on carbohydrate metabolism and the lack of toxic effects of the vitamin at pharmacological doses suggest that biotin could be used in the development of new therapeutics in the treatment of hyperglycemia and hyperlipidemia, an area that we are actively investigating."
Accelerade

- http://www.accelerade.com/
- Magic 4:1 ratio of carbohydrate to protein

ENDUROX R4

- 4:1 ratio of carbs/protein like Accerade
- Claims:
  1. Restore electrolytes and water.
  2. Replenish glycogen stores rapidly.
  3. Reduce muscle and oxidative stress.
  4. Rebuild muscle protein.
- From their website: "Endurox R4 is more than a sports drink. It is an advanced nutritional system proven to dramatically enhance exercise performance and speed recovery."
ENDUROX®

- Endurox® (regular formula) - 800 mg standardized extract of ciwujia/2 caplets.

- Their claim: "Whether you work out two, three, or more times a week, Endurox can increase your workout energy and reduce your body fat. During a workout Endurox shifts your body's workout energy source from carbohydrate to fat. This carbohydrate shift increases fat metabolism and slows the lactic acid buildup that produces muscle soreness and fatigue."


Abstract:
Claims that ENDUROX enhances performance by altering metabolic responses to exercise were tested. In a double-blind crossover design, 10 male subjects were randomly assigned to consume 400 mg of placebo or 800 mg ENDUROX for 7 days. Cycle ergometry was performed for 30 minutes at 25%, followed by 10 min at 65% of peak oxygen consumption. After a 1-week washout period, subjects performed the identical exercise protocol following 7 days of reciprocal supplemental conditions. Expired gases were collected and analyzed continuously for oxygen consumption, minute ventilation, and respiratory exchange ratio. Heart rate, blood pressure, rating of perceived exertion, blood lactate, and serum glycerol data were also collected at regular intervals. A two-way ANOVA with repeated measures revealed no significant main or interaction effects involving group differences (p > 0.05) between trials for any variable during rest, 25% or 65% (VO2 peak), or recovery. Our findings do not support the ergogenic claims for ENDUROX.
More Details on ENDUROX study

- Ciwujia - claims to increase fat oxidation by 43%, increase oxygen consumption by 13%, reduce lactate accumulation by 32% and accelerate hear rate recovery by 22% following exercise
- Study used 10 students

What the study concluded:

"In conclusion, the present data do not support the purported ergogenic claims of ENDUROX to enhance fat metabolism, improve oxygen consumption, or reduce blood lactate associated with submaximal exercise or to speed postexercise heart rate recovery."


HammerGel - or more broadly - Hammer nutrition

- The website claims that exercise lasting longer than 2 hours requires protein component in fuel
- **Hammer Nutrition**
  - All carb fuels - Hammer Gel and HEED
  - Carb/protein Fuels
    - Sustained Energy : 7:1 ratio of simple sugars to soy protein
    - Perpetuem :75% carbohydrates (from long-chain maltodextrins-no added simple sugars), 13% fatty acids from a specially made long-chain lyso-lecithin, and nearly 10% soy protein
Perpetuem

• From the Hammer Nutrition website:
"We designed it primarily for extreme endurance events lasting about six hours to many days. Perpetuem contains 75% carbohydrates (from long-chain maltodextrins-no added simple sugars), 13% fatty acids from a specially made long-chain lyso-lecithin, and nearly 10% soy protein. A small portion of fat seems to cue your body to more liberally release its fatty acids stores, which account for up to 70% of one's energy requirements in long bouts of exercise. A little fat in the fuel also slightly slows the rate of digestion and thus promotes 'caloric satisfaction,' another attractive plus during primarily aerobic ultra-long distance events. Perpetuem provides maximal benefits at an aerobic pace (under 70% MHR)."

(http://www.e-caps.com/za/ECP?PAGE=ARTICLE&CAT=VEGGIE&ARTICLE.ID=1252)

A word from the nutritionist

• Platinum bar (100 calorie bar) equivalent:
  – 1 c plain yoghurt - flavored with honey or jam
  – 4 - 6 almonds
• Which give you the same nutrition as the bar
Applications to Triathlons


From the paper's abstract:
"The aims of this study were to compare different tracer methods to assess whole body protein turnover during 6 h of prolonged endurance exercise when carbohydrate was ingested throughout the exercise period and to investigate whether addition of protein can improve protein balance. Eight endurance-trained athletes were studied on two different occasions at rest (4 h), during 6 h of exercise at 50% of maximal O2 uptake (in sequential order: 2.5 h of cycling, 1 h of running, and 2.5 h of cycling), and during subsequent recovery (4 h). Subjects ingested carbohydrate (CHO trial; 0.7 g CHO.kg(-1).h(-1)) or carbohydrate/protein beverages (CHO + PRO trial; 0.7 g CHO.kg(-1).h(-1) and 0.25 g PRO.kg(-1).h(-1)) at 30-min intervals during the entire study."

Conclusions from the study

From the paper's abstract:
"We conclude that, even during 6 h or exhaustive exercise in trained athletes using carbohydrate supplements, net protein oxidation does not increase compared with the resting state and/or postexercise recovery. Combined ingestion of protein and carbohydrate improves net protein balance at rest as well as during exercise and postexercise recovery."
Lucozade Sport

- European company - produced by GlaxoSmithKline
- Carbohydrate based drinks

Revisiting the carbohydrate/protein debate

- Two papers:
  1. Nutritional strategies for promoting fat utilization and delaying the onset of fatigue during prolonged exercise by Lambert et al, 1997
Abstract: Carbohydrate ingestion before and during endurance exercise delays the onset of fatigue (reduced power output). Therefore, endurance athletes are recommended to ingest diets high in carbohydrate (70% of total energy) during competition and training. However, increasing the availability of plasma free fatty acids has been shown to slow the rate of muscle and liver glycogen depletion by promoting the utilization of fat. Ingested fat, in the form of long-chain (C16-22) triacylglycerols, is largely unavailable during acute exercise, but medium-chain (C8-10) triacylglycerols are rapidly absorbed and oxidized. We have shown that the ingestion of medium-chain triacylglycerols in combination with carbohydrate spares muscle carbohydrate stores during 2 h of submaximal (< 70% VO2 peak) cycling exercise, and improves 40 km time-trial performance. These data suggest that by combining carbohydrate and medium-chain triacylglycerols as a pre-exercise supplement and as a nutritional supplement during exercise, fat oxidation will be enhanced, and endogenous carbohydrate will be spared. We have also examined the chronic metabolic adaptations and effects on substrate utilization and endurance performance when athletes ingest a diet that is high in fat (>70% by energy). Dietary fat adaptation for a period of at least 2-4 weeks has resulted in a nearly two-fold increase in resistance to fatigue during prolonged, low- to moderate-intensity cycling (< 70% VO2 peak). Moreover, preliminary studies suggest that mean cycling 20 km time-trial performance following prolonged submaximal exercise is enhanced by 80 s after dietary fat adaptation and 3 days of carbohydrate loading. Thus the relative contribution of fuel substrate to prolonged endurance activity may be modified by training, pre-exercise feeding, habitual diet, or by artificially altering the hormonal milieu or the availability of circulating fuels. The time course and dose-response of these effects on maximizing the oxidative contribution of fat for exercise metabolism and in exercise performance have not been systematically studied during moderate- to high-intensity exercise in humans.
Fat utilization during exercise


Caffeine

- Why do we use it?
- What are its effects?
Caffeine

- Three papers (see readings list):

Paper #1 - Titlow et al, 1991

- Looked at the effects of 200 mg caffeine (two cups of coffee) on metabolism during 60 min submaximal (60 % VO$_2$) treadmill exercise in five males
- They looked at glucose, lactic acid, triglyceride free fatty acid, hemoglobin and hematocrit responses in a double-blind study. They also looked at the respiratory exchange ratio (R), Perceived exertion (RPE) and oxygen uptake.
- There was no effect on performance or substrate metabolism
Paper #2 - Spriet - Caffeine and Performance

• Review article of the current literature (1995)
• Five categories;
  – Caffeine and endurance Exercise Performance
  – Caffeine and graded exercise Performance
  – Caffeine and Short-term Exercise Performance
  – Caffeine and sprint performance
  – Practical aspects of caffeine ingestion

• Caffeine and endurance Exercise Performance
  – Caffeine in doses of 3 to 9 mg/kg body weight produces significant endurance performance improvements in recreational and elite athletes.
  – There is sufficient variability to preclude predicting an increase in performance at a given caffeine dosage for any one individual - you must do the experiment yourself!
  – No metabolic explanation is clear
Paper #2 - Spriet - Caffeine and Performance

• Caffeine and graded exercise Performance
  – Looking at graded exercise protocols that last 8 to 20 minutes and are designed to measure VO$_2$ max
  – No effect of caffeine on VO$_2$ max and time to exhaustion, but there were problems with experimental design - for instance not taking into account habitual caffeine dose.

• Caffeine and Short-term Exercise Performance
  – Athletic performance during short-term intense exercise (90-100 % VO$_2$ max) lasting ~ 5 minutes
  – Exercise intensity requires maximal provision of energy from both aerobic and anaerobic sources.
  – Caffeine increases performance but the improvement is not always significant.
  – Mechanism - unknown - possibilities are enhanced anaerobic energy provision, direct effects on muscle ion handling and a central nervous component related to the sensation of effort.
Paper #2 - Sprriet - Caffeine and Performance

- Caffeine and sprint performance
  - Sprint is exercise at a power output two- to threefold greater than that required to elicit VO₂ max or sporting events lasting less than 90 s
  - ~80% of the total in the first 30 s, ~70% over 60 s and ~60-65% over the total 90 s.
  - One set of authors saw no effect on maximal bouts of cycling, but another group saw a 7% improvement in maximal output of a 6 s sprint after 250 mg ingestion of caffeine.
  - Also looked at 100-m freestyle swims in 7 trained vs. untrained swimmers

Paper #2 - Spriet - Caffeine and Performance

• Practical aspects of caffeine ingestion
  – IOC limits athletes to 12 µg caffeine/mL which relates to a 70 kg person drank 3 - 4 mugs or 6 regular-sized cups of drip-percolated coffee ~ 1 hour before exercise, exercised for 1 - 1.5 hour and then gave a urine sample.
  – This is difficult to get to unless you are taking tablets or suppositories to attempt to improve performance. (American cycling team used this in the 1984 Olympics)

• Practical aspects of caffeine ingestion
  – 10 - 15 mg/kg is not recommended because caffeine plasma levels increase toward the reported toxic range for Caffeine (200 µM)
Paper #2 - Spriet - Caffeine and Performance

Final line of the paper:
"The ergogenic effects of caffeine are present when urinary caffeine levels are well below the limit (12 micrograms/ml) allowed by the International Olympic Committee. This raises serious ethical issues regarding the use of caffeine to improve athletic performance. Perhaps caffeine should be added to the list of banned substances, thereby requiring athletes to abstain from caffeine ingestion 48-72 hr prior to competition.

Paper #3-Magkos and Kavouras

• Everything you ever wanted to know about how caffeine gets metabolized in your body.
• Two items
  – Caffeine amounts in food
  – Caffeine and effects on sports
Paper #3-Magkos and Kavouras
caffeine amounts in food

<table>
<thead>
<tr>
<th>Source</th>
<th>Caffeine Content (mg)</th>
<th>Volume or Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee</td>
<td>40 - 180</td>
<td>150 mL</td>
</tr>
<tr>
<td>Tea</td>
<td>25 - 50</td>
<td>150 mL</td>
</tr>
<tr>
<td>Cocoa</td>
<td>5 - 10</td>
<td>150 mL</td>
</tr>
<tr>
<td>Chocolate bars</td>
<td>5 - 20</td>
<td>100 g</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>20 - 40</td>
<td>250 mL</td>
</tr>
<tr>
<td>Energy drinks</td>
<td>30 - 85</td>
<td>250 mL</td>
</tr>
<tr>
<td>Over the counter medications</td>
<td>30 - 200</td>
<td>1 tablet</td>
</tr>
</tbody>
</table>

Figure by MIT OCW. Adapted from Table 1 in Magkos, Faidon, and Stavros A. Kavouras. “Caffeine use in sports, pharmacokinetics in man, and cellular mechanisms of action.” Critical Reviews in Food Science and Nutrition 45 (2005): 535-562.

Paper #3-Magkos and Kavouras
caffeine and effect on exercise

Table has been removed due to copyright restrictions.

Alcohol and athletic performance

- One-paper:

Shirreffs, Susan M., and Ronald J. Maughan.

"The affect of alcohol on athletic performance."


Effect of alcohol on athletic performance


Paper's abstract:

The use of alcohol is often intimately associated with sport. As well as providing a source of energy, alcohol (ethanol) has metabolic, cardiovascular, thermoregulatory, and neuromuscular actions that may affect exercise performance. Strength is minimally affected, and performance impairments depend on the dose of alcohol and subject habituation to alcohol intake, exercise duration, environmental conditions, and other factors. Central nervous system function is impaired at high doses, resulting in decrements in cognitive function and motor skill, as well as behavioral changes that may have adverse effects on performance. Effects may persist for hours after intoxication.
Effects of ethanol on glycogen metabolism

- Resynthesis of the glycogen stores in liver and muscle is one of the key goals of athletes after intensive training or competition and it is well recognized that ethanol has a variety of effects on carbohydrate metabolism in skeletal muscle and liver. (Shirreffs and Maughan 2006)

<table>
<thead>
<tr>
<th>Diet</th>
<th>Recovery duration, h</th>
<th>Control</th>
<th>Alcohol displacement</th>
<th>Alcohol + carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8</td>
<td>44.6 ± 6</td>
<td>24.4 ± 7</td>
<td>36.2 ± 8</td>
</tr>
<tr>
<td>Alcohol displacement</td>
<td>24</td>
<td>81.7 ± 5</td>
<td>68.4 ± 5</td>
<td>85.1 ± 9</td>
</tr>
</tbody>
</table>

Data are mean ± SE.

Hydration and alcohol

- Alcohol is a diuretic
- Excess urine production of about 10 mL for each gram of alcohol ingested (this affect can be eliminated if you are superhydrated)
- Concentrated alcohol solutions will result in a net negative fluid balance - 25 mL measure of 40% ethanol contains 10 mL of alcohol and 15 mL of water resulting in a urine output of about 100 mL and net negative water balance of 85 mL
- Ingestion of large volumes of dilute alcohol will result in a water diuresis (high urine flow) but should promote restoration of fluid balance after sweat loss provided that there is also an intake of sodium.

Effects of ethanol on glycogen metabolism

<table>
<thead>
<tr>
<th>Diet</th>
<th>Recovery duration, h</th>
<th>Control</th>
<th>Alcohol displacement</th>
<th>Alcohol + carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>84.6 ± 8</td>
<td>24.4 ± 7</td>
<td>56.2 ± 8</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>81.7 ± 5</td>
<td>68.4 ± 5</td>
<td>85.1 ± 9</td>
</tr>
</tbody>
</table>

Data are mean ± SE.


High carbohydrate (control) and alcohol + carbohydrate there appeared to be no great effect when alcohol is consumed
But there was a high variability in data
It is likely that athletes who consume large amounts of alcohol during the recovery period after training or competition will have a reduced carbohydrate intake, either as a result of a decrease total (non alcohol) energy intake or because of a failure to follow the recommended eating strategies at this time.
Thermoregulation and Alcohol

• Ingestion of alcohol (2.5 mL/kg) prior to prolonged (3 hours) exercise in the cold resulted in increased heat loss, though this effect was somewhat attenuated by co-ingestion of glucose.

(Shirreffs and Maughan 2006)

Effects of alcohol on injury and incapacity

• Prior alcohol consumption appears to increase the risk of sports-related injury.
• May be a consequence of increase risk-taking behaviors as alcohol removes some of the restraint that normally control behavior

(Shirreffs and Maughan 2006)
Alcohol on athletic Performance

Conclusions
Alcohol, as ethanol, is consumed by a significant number of athletes, as it is in the general population. Alcohol has been demonstrated to impact on exercise performance but the extent to which this occurs depends on many factors, including the exercise mode and duration and the individual's habituation to alcohol intake.

Supplements

- See the triathlete magazine article on the website
  - Anyone got any good supplements that they are using?
Next week

• Guest speaker - Dr. Holly Sweet -
  – Psychology of sports first 45 minutes
  – Cognitive performance and exercise
• Following week - field trip to International Bike Center
• Upcoming Sports scandals-April 25th
  – Anyone want to pick their favorite scandal and present it to the class?