Whole Body and Tissue Specific Effects of Energy Drinks on Metabolism: Beyond Skeletal Muscle

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The Use and Biology of Energy Drinks: Current Knowledge and Critical Gaps
Conflicts

Present
• No conflicts to declare.

Past
• Expert advisory board on Energy Drinks, Health Canada.
• Funding from the National Coffee Association.
Outline

*PMID numbers indicate references throughout
Metabolic Considerations

220 Calories (16oz)
58g Carbohydrate
High Fructose Corn Syrup
142 mg Caffeine
16 cans = 3500 kcal
= 1 pound of fat

Energy Balance

Food intake

Weight gain

Weight maintenance

Energy expenditure

Weight loss
Metabolic Considerations

- In 2010, more than one third of children and adolescents were overweight or obese.

Source: CDC, NCSL Childhood Overweight and Obesity Trends
Metabolic considerations

• We spend very little time in the ‘fasted’ state

• Most in an ‘over-fed’ state
Metabolic considerations

• Not all organs ‘see’ the same concentration of active components.

• Responses are tissue-specific but do not occur in isolation.

• Responses vary with repeated exposure.

• Individual differences.

• Examination of individual components ≠ mixtures.

• Acute vs. chronic?

Gastrointestinal

• Incretins, secreted from GI tract account for 50 to 70% of postprandial insulin secretion.
• Glucagon like peptide (GLP-1), Glucose dependent insulinotropic peptide (GIP), others.
• Ginsenosides stimulate GLP-1 secretion both in vivo and in vitro (PMID 23444389).
• Carbohydrate – secretion
• Caffeine – controversial
• Other ?

*Gastric emptying, intestinal permeability, intestinal transport, rate of absorption, orocecal transit time?*
Gut Microbiota

• Host-microbe interactions essential to optimal health. Implicated in numerous metabolic states (dysbiosis).

• Fructose, acquisition of a westernized microbiome with altered metabolic capacity? (PMID 22686435).

• Taurine, 95% urinary excretion, 25% as sulfate (2 –Hydroxyethanesulfonate) (PMID 223319970, 1159536)

• Guarana, traditional use for diarrhea. Positive impact?

• Artificial sweeteners?
Hepatic Metabolism

• Gastrointestinal system, highest concentration of active components in energy drinks.
• Is not a mere by-stander, but active metabolic ‘player’.
• **CAFFEINE**: fractional extraction is rapid. Active caffeine metabolites are released.

CAFFEINE + CARBOHYDRATES?......what impact does caffeine have on hepatic glucose disposal?

• Caffeine increases hepatic glucose uptake.
• Not stored, 40% is converted to lactate.
• Why no enhanced whole body glucose disposal?
Cardiovascular System

• Caffeine containing energy drinks well tolerated in healthy, adult population.
• Rapid tolerance to caffeine (3 days)
• Slight increased in total peripheral resistance, but tissue specific effects are not consistent.
• LT Δ Blood pressure (coffee); 1.2/0.5 systolic, 2.4/1.2 mmHg diastolic (PMID 15834273)
• Green tea (PMID 18525384), taurine post-MI (PMID 23890888), L-carnitine (CVD) (PMID 23597877)
Adipose Tissue

• Caffeine in energy drinks, elevated circulating free fatty acids (FFA). ↑ FFA = insulin resistance.

• Lipid Challenge + Caffeine have additive decrease in glucose tolerance.

• Dampened GLP-1, GIP

• Weight maintenance

• Implications for obese, T2D, T1D?

• Antioxidants?
Antioxidants

LESSONS FROM COFFEE?

• Coffee - Dose dependent risk reduction for Type 2 Diabetes (Van Dam and Hu, PMID 15998896)

• Guarana: antioxidant activities, polyphenols including catechin, epicatechin (EC) (Food Chemistry 104(3), 1258, 2007).

• Green tea: polyphenols, EC (PMID 20558130)

• Taurine: ability to scavenge reactive oxygen species and reduce lipid peroxidation, reduce ER stress. Useful in NAFLD, CVD? (PMID: 21957160)
Whole Body Metabolism

Energy Drink Consumption

• **CHO + CAFFEINE (1h)**: impaired glucose tolerance, dose dependent (PMID 23438224).

• Increase insulin AUC (25-42%) (PMID 920859811)

• **TAURINE**: Excreted in urine without equilibration with the slowly exchangeable pool, increases in total body taurine are modest (PMID 223319970).

• **GINSENG and GREEN TEA** appear to be beneficial to glucose and fat metabolism (esp. obese?).

• **B VITS.** Dependent on nutritional status. Modest?
Summary

- GI? Microbiota?
- Enhanced hepatic glucose uptake
- Acute - Impaired whole body glucose disposal. Chronic?
- Modest cardiovascular impacts
- Elevation in circulating FFA
Summary

• Metabolically harmful effects of Energy Drinks involve caloric content, high fructose corn syrup, acute effects on blood glucose and insulin secretion.

• Plant based ingredients are likely better than CHO-Caffeine mixtures, but the quantity and quality of ingredients are questionable.

• *Lifetime of consumption.....slightly worse than caffeinated, sweetened soda beverages?*

• *CHILDHOOD OBESITY* (PMID 23321486, BMJ)
Acknowledgements

- Terry Graham
- Jasmine Tunnicliffe
- Theresa Cowan
- Kendra Ardell
- Hans Vogel
- Dustin Hittel