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

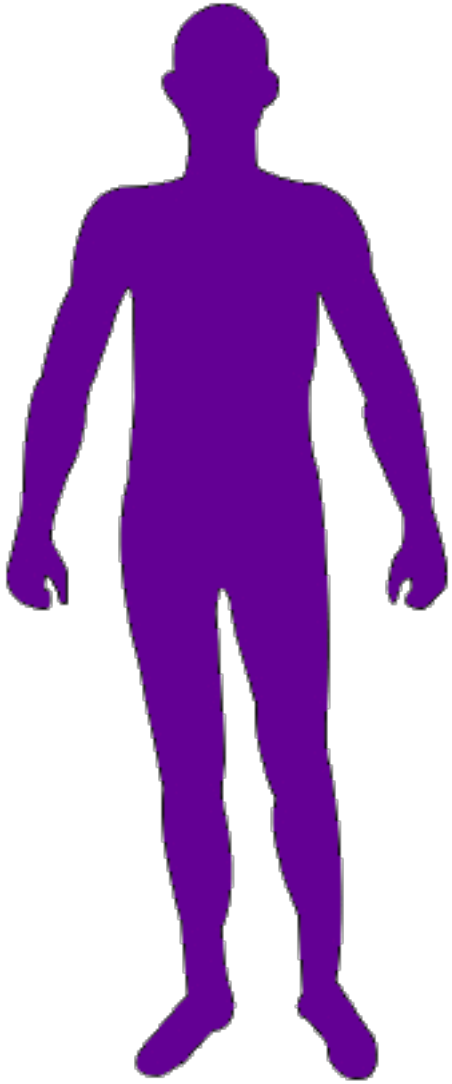
Present

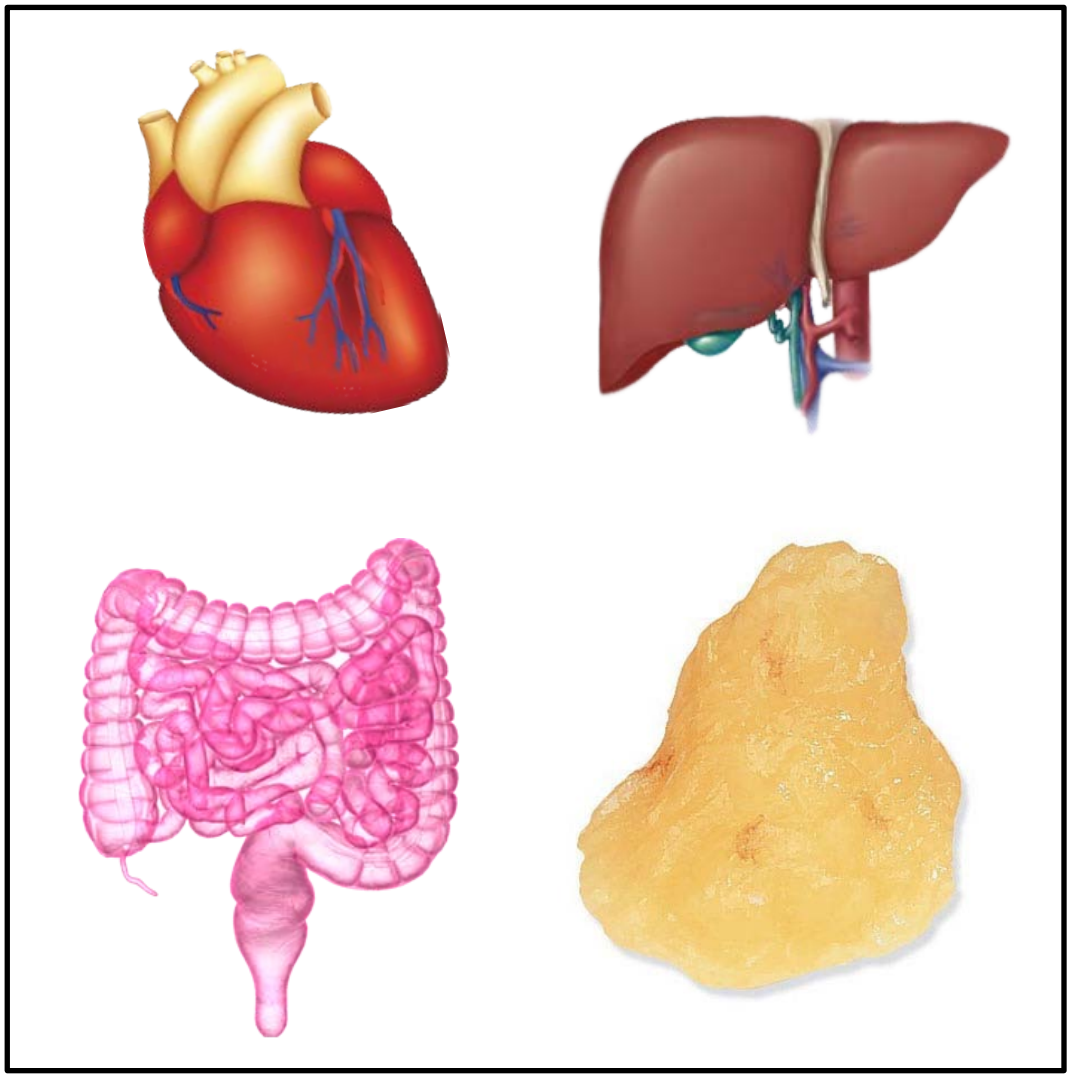
- No conflicts to declare.

Past

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

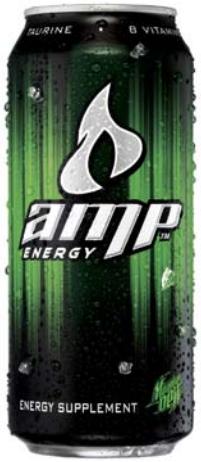
Outline





*PMID numbers indicate references throughout

Metabolic Considerations



220 Calories (16oz)

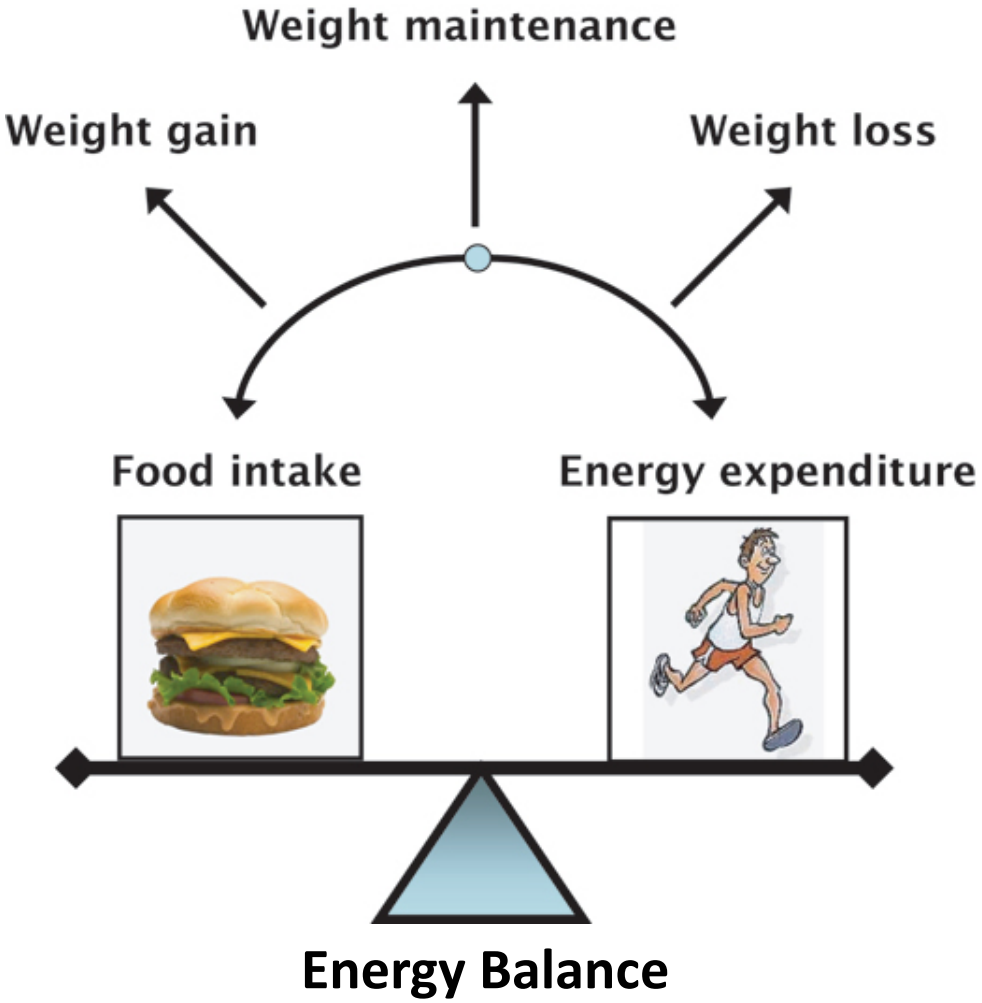
58g Carbohydrate

High Fructose Corn Syrup

142 mg Caffeine

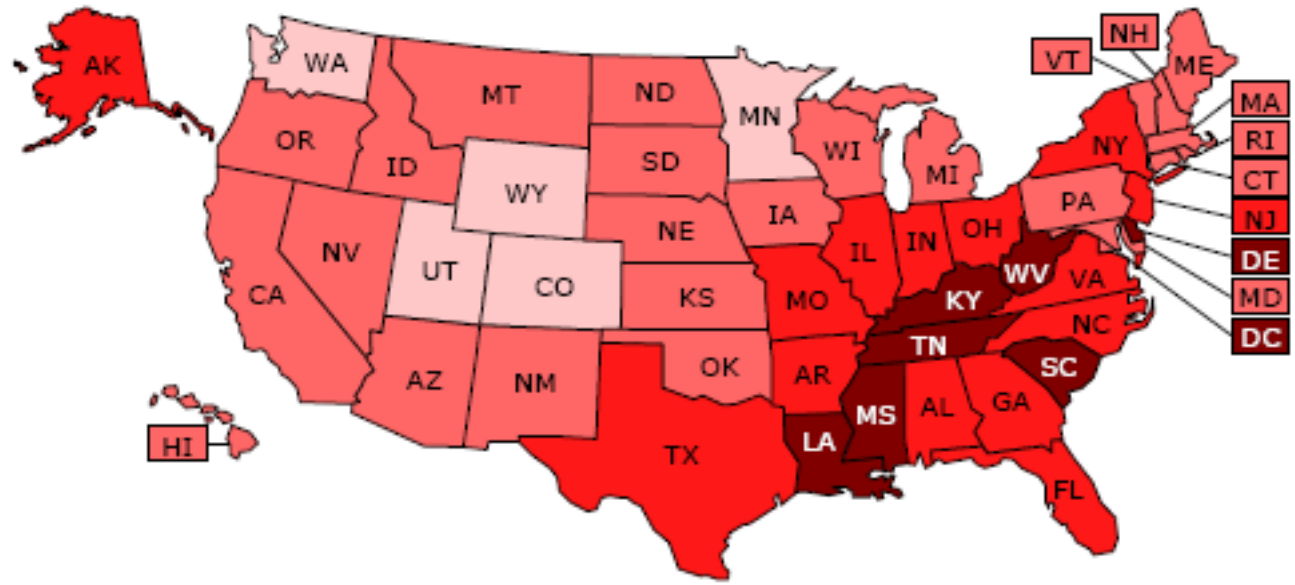
16 cans = 3500 kcal

= 1 pound of fat



Metabolic Considerations

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

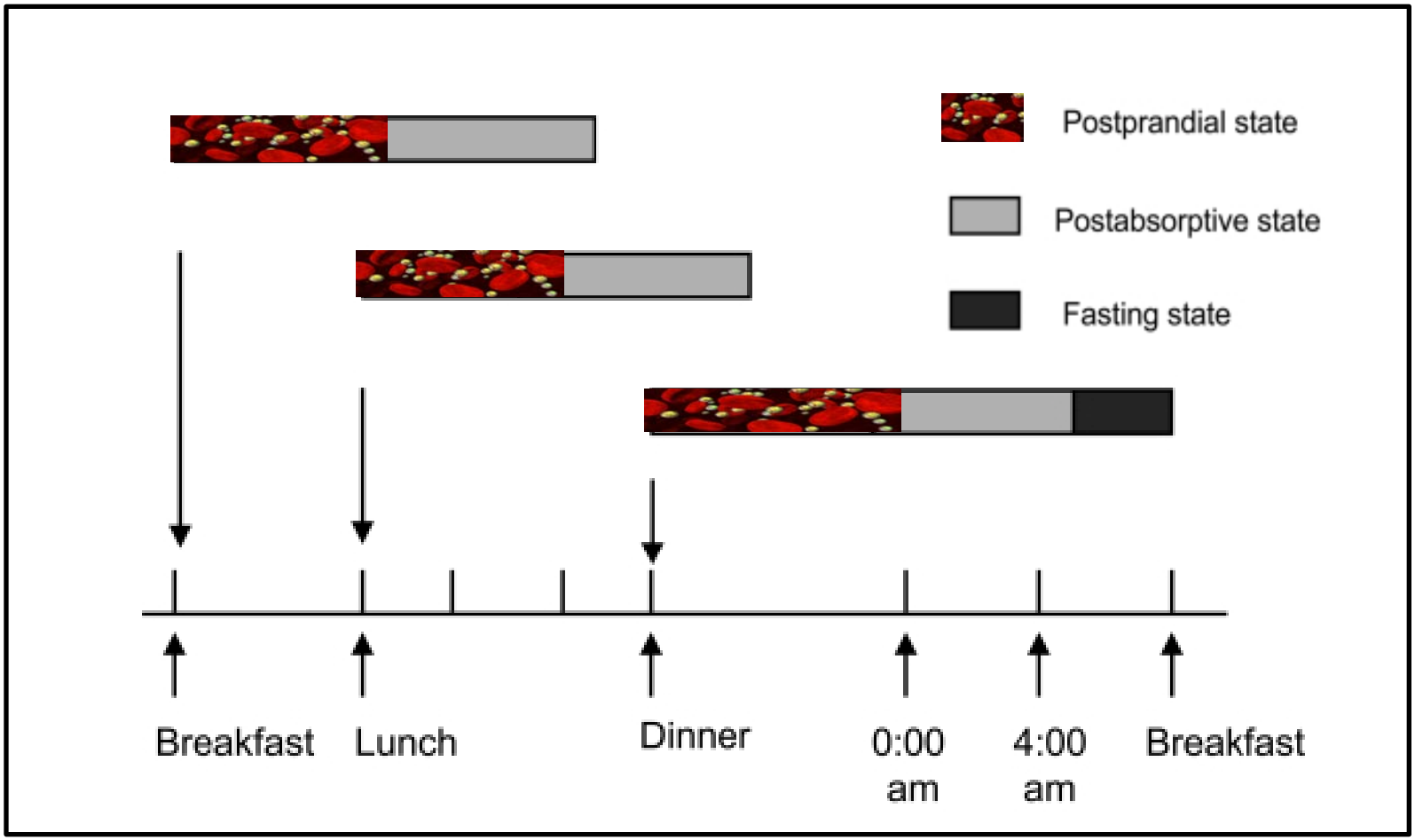


35.1% - 40%
30.1% - 35%
25.1% - 30%
20% - 25%

Source: CDC, NCSL Childhood Overweight and Obesity Trends

Metabolic considerations

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

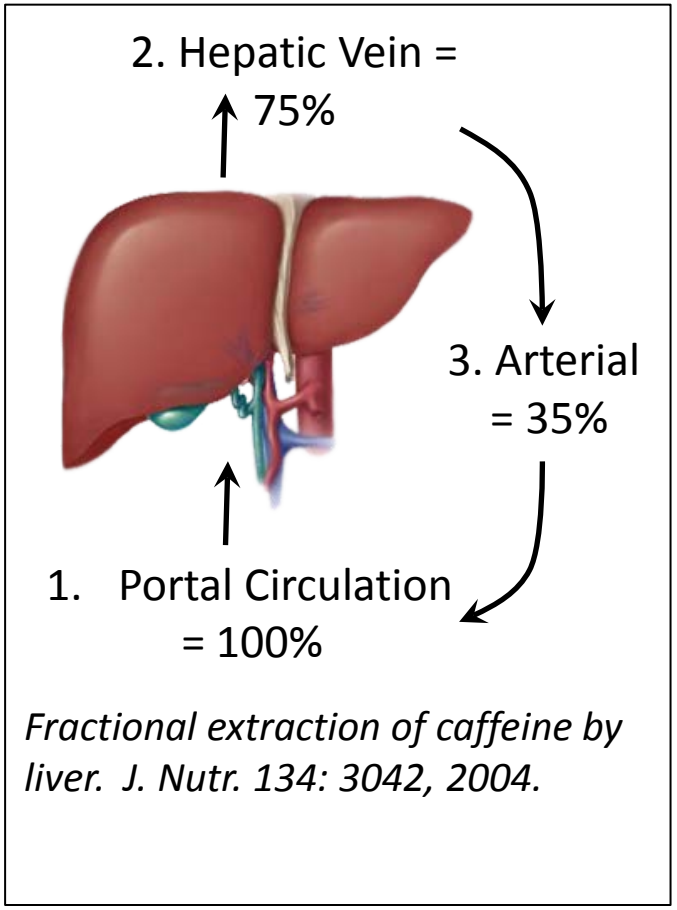


- Most in an ‘over-fed’ state

(PMID 18227477)

Metabolic considerations

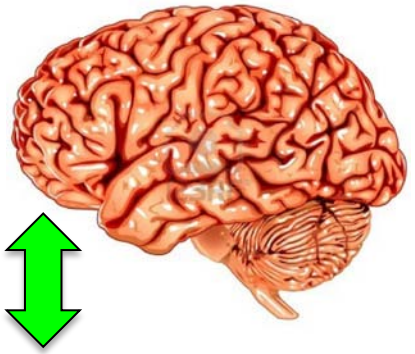
- Not all organs '*see*' the same concentration of active components.
- Responses are tissue-specific but do not occur in isolation.
- Responses vary with repeated exposure.
- Individual differences.
- Examination of individual components ≠ mixtures.
- Acute vs. chronic?



Fractional extraction of caffeine by liver. J. Nutr. 134: 3042, 2004.

Gastrointestinal

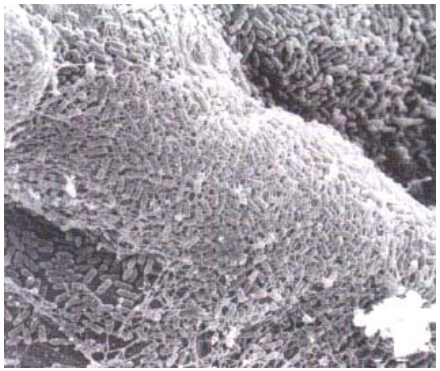
- Incretins, secreted from GI tract account for 50 to 70% of postprandial insulin secretion.
- Glucagon like peptide (GLP-1), Glucose dependent insulinotropic peptide (GIP), others.
- Ginsenosides stimulate GLP-1 secretion both in vivo and in vitro (PMID 23444389).
- Carbohydrate – secretion
- Caffeine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

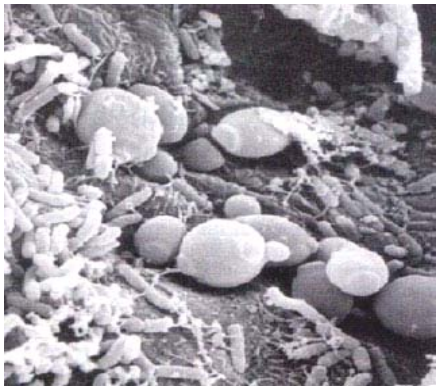


Gastric emptying, intestinal permeability, intestinal transport, rate of absorption, orocecal transit time?

Gut Microbiota

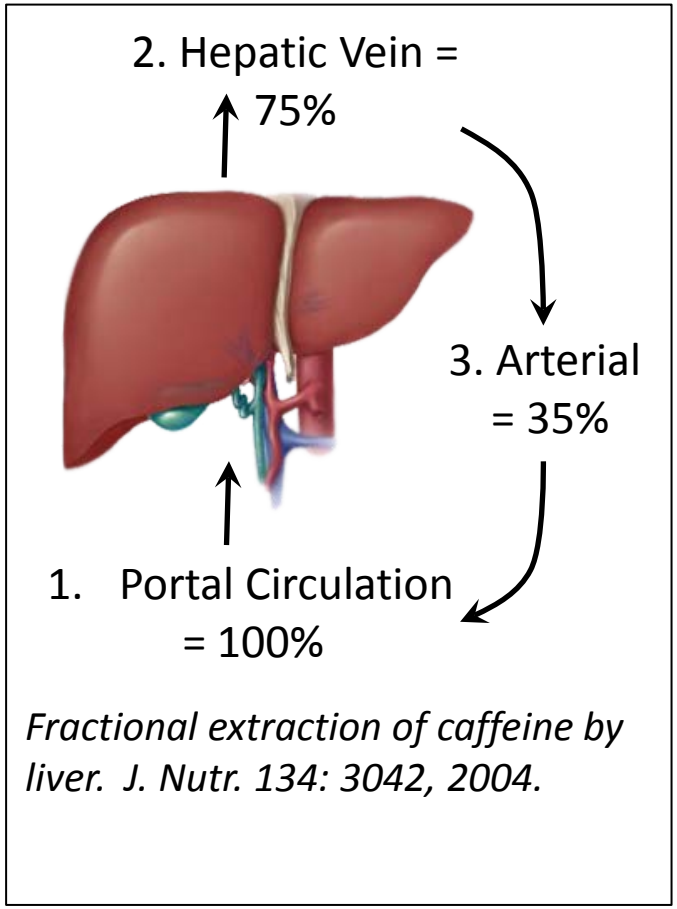
- Host-microbe interactions essential to optimal health. Implicated in numerous metabolic states (dysbiosis).
- Fructose, acquisition of a westernized microbiome with altered metabolic capacity? (PMID 22686435).
- Taurine, 95% urinary excretion, 25% as sulfate (2 –Hydroxyethanesulfonate)(PMID 223319970, 1159536)
- Guarana, traditional use for diarrhea. Positive impact?
- Artificial sweeteners?





Hepatic Metabolism

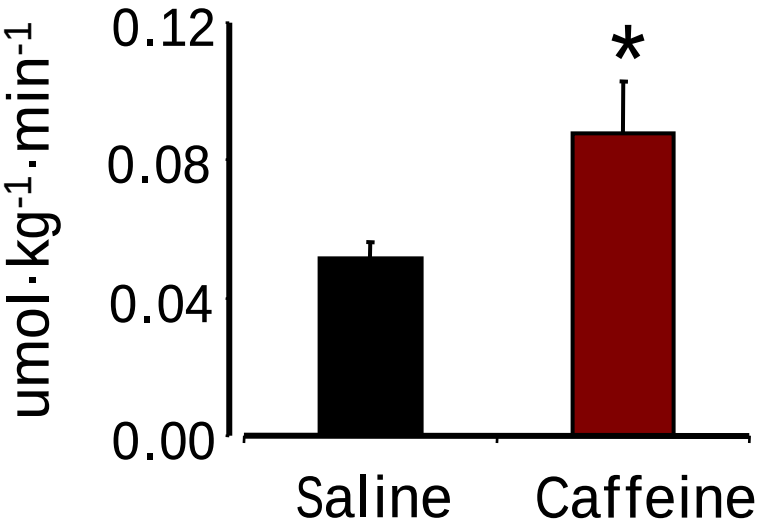
- Gastrointestinal system, highest concentration of active components in energy drinks.
- Is not a mere by-stander, but active metabolic ‘player’.
- **CAFFEINE:** fractional extraction is rapid. Active caffeine metabolites are released.



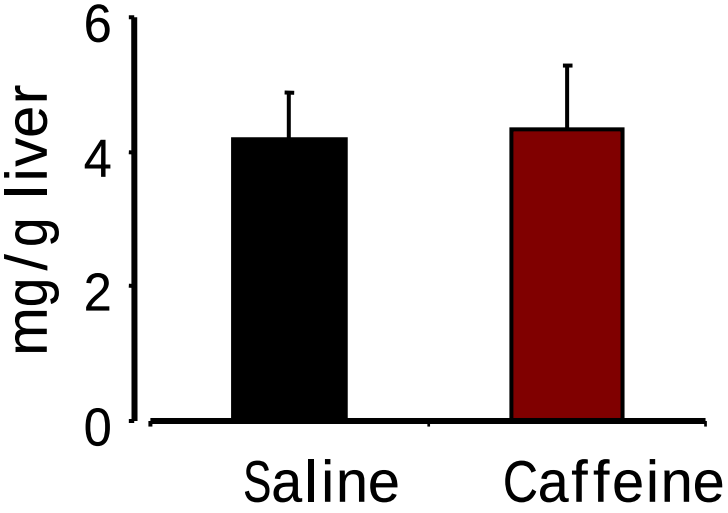
Fractional extraction of caffeine by liver. J. Nutr. 134: 3042, 2004.

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

Net Hepatic Glucose Fractional Extraction

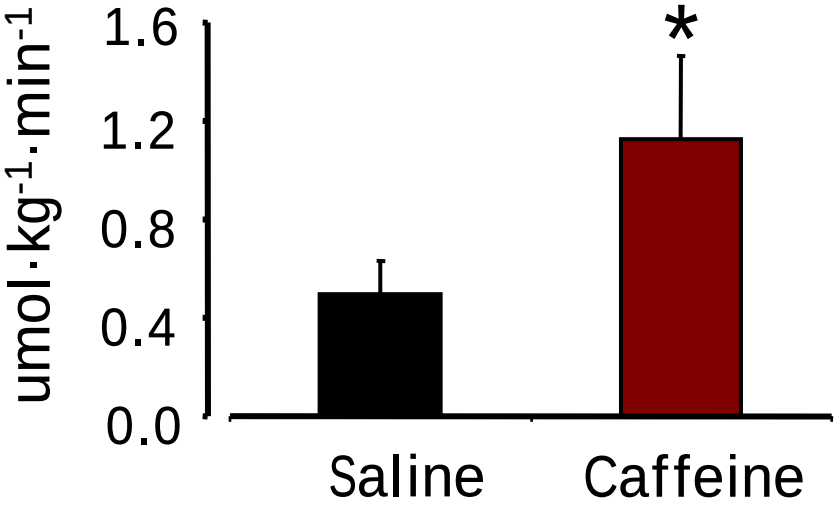


Hepatic Glycogen Synthesized



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

Net Hepatic Lactate Output

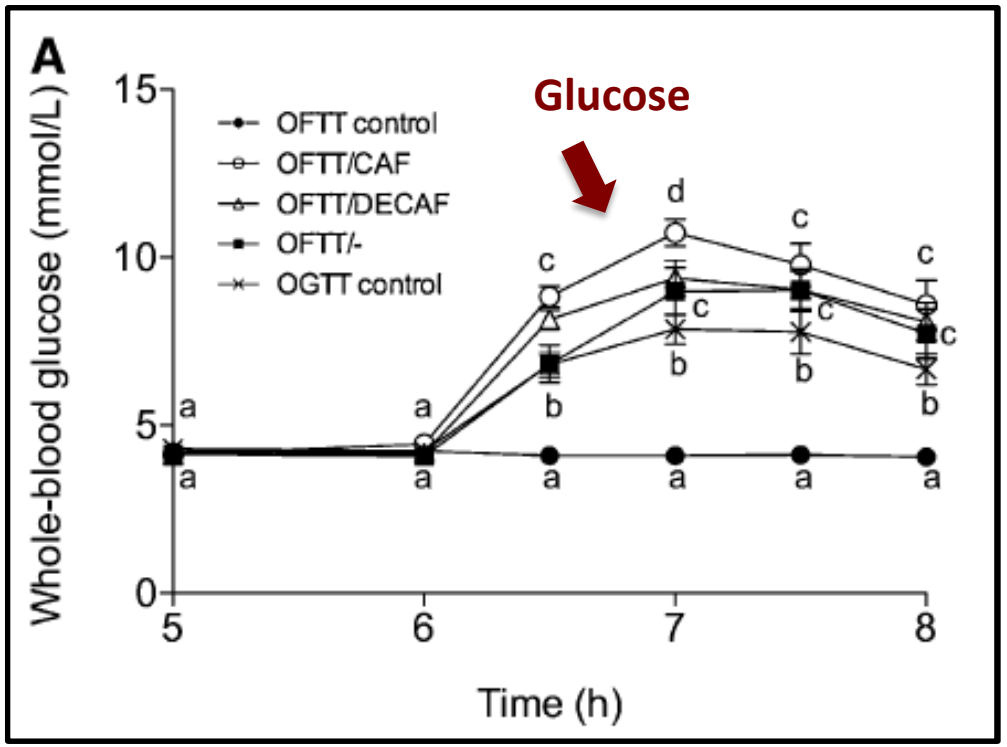


Cardiovascular System

- 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

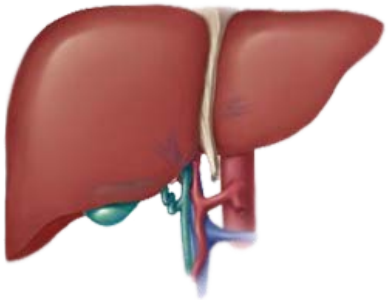
LESSONS FROM COFFEE?

- 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)

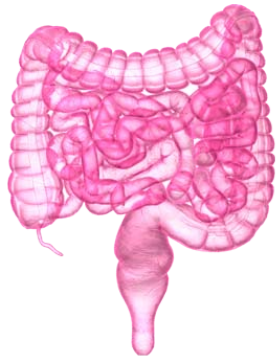
Whole Body Metabolism

Energy Drink Consumption

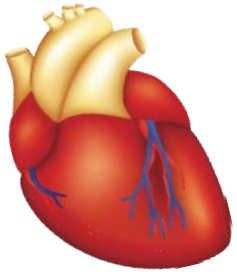
- CHO + CAFFEINE (1h): impaired glucose tolerance, dose dependent (PMID 23438224).
- Increase insulin AUC (25-42%)(PMID 920859811)
- TAURINE: Excreted in urine without equilibration with the slowly exchangeable pool, increases in total body taurine are modest (PMID 223319970).
- GINSENG and GREEN TEA 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)

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