

From Cocoa Bean to Chocolate Bar: The Science Behind the Superfruit

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**HERSHEY CENTER FOR
HEALTH & NUTRITION®**

Mission Statement

The HERSHEY CENTER FOR HEALTH & NUTRITION investigates and promotes the chemistry and health benefits of cocoa, chocolate, nuts and other ingredients. The results of these investigations guide new products and product development for The Hershey Company. Health benefits and cultural aspects of cocoa, chocolate and other key ingredients are communicated to Hershey employees, customers, consumers and key stakeholders.



Outline

- Nature to Nutrition: Where does cocoa come from?
- How cocoa & chocolate are made
- Why would natural cocoa have benefits to health?
- Antioxidant or flavanol?
- Review of the literature
- Emerging research
- Natural Cocoa and Dark Chocolate as Part of a Balanced Lifestyle



Nature to Nutrition: Where does cocoa come from?



Geographical Origins of Cocoa



Cocoa trees grow only in tropical regions +/- 20° latitude from the Equator in tropical rain forests. Major regions are Central & South America, Central Africa and Indonesia.



Where Does Cocoa Come From?

- In English, Cocoa is both the plant and the powder
- Cacao is commonly used term from the romance languages
- “% Cacao” is the proportion of the product made from the cocoa bean
- *Theobroma cacao* is the scientific name
- “Food of the gods”



Cocoa beans are fermented in banana leaves and dried in the sun



Ancient Medicinal Uses of Cocoa

Dillingner et al. J Nutr. 2000.

- >150 medicinal uses of cacao
- Cardiovascular Disease (CVD) Related uses:
 - "faint of heart"
 - Angina (reduces)
 - Blood (generates/produces)
 - Heart palpitations (relieves)
 - Heart (strengthens/vivifies)
 - Longevity (prolongs)



Ancient Uses of Cocoa: A Modern Example

Hollenberg et al. J Food Comp Anal. 2001.

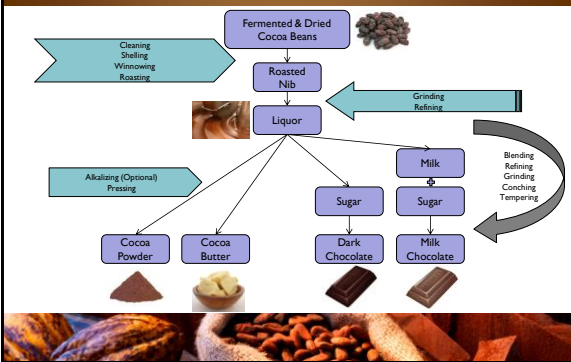
- KUNA Amerinds:
 - Indigenous population off the coast of Panama
 - Traditional high salt diet
 - Showed no rise in blood pressure with age
 - Immigrants did develop hypertension
 - Island dwelling Kuna's consume an average of 5 cups of cocoa per day



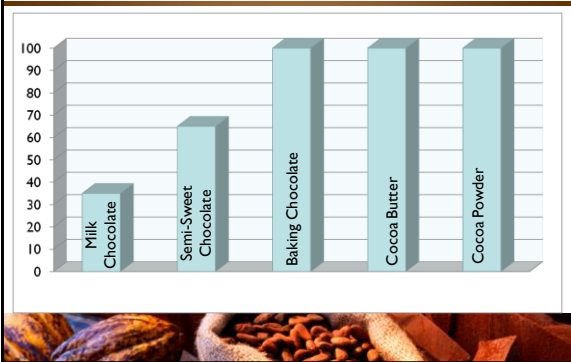
How Cocoa & Chocolate are Made



Cocoa Pod to Chocolate Bar

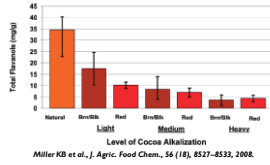


% Cacao refers to the % weight of all ingredients from the cocoa bean in a product



Alkalized v. Non-Alkalized Cocoa

- Many products contain alkalized or "dutch" cocoa powder to give it a darker color, smoother flavor and increased solubility.
 - During the alkalization/dutching process, the flavanol content of cocoa powder is reduced.
 - The amount of flavanol reduction will depend on the level of alkalization.
 - In general, the darker the color of cocoa powder, the lower the flavanol content.
- If the ingredient list states "cocoa processed with alkali" or "dutch cocoa" it will have a reduction in flavanols.

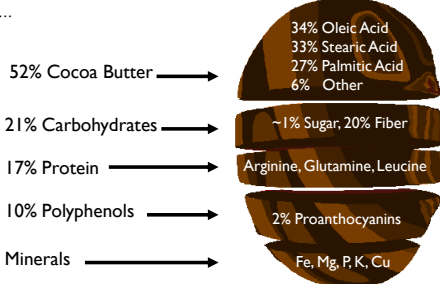


Why would natural cocoa have benefits to health?

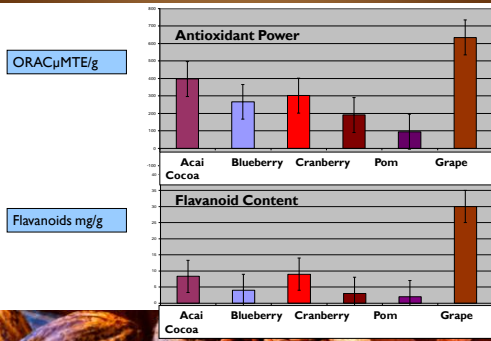


What nutritional compounds are in the cocoa bean?

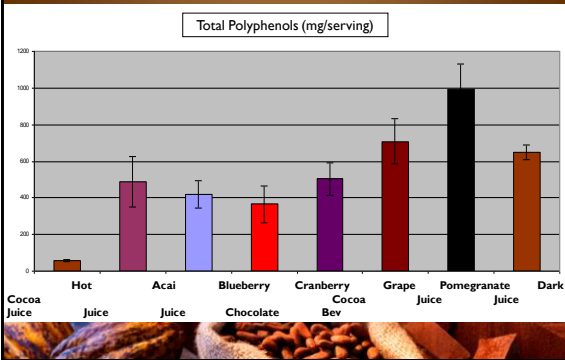
by weight...



Cocoa Compared to "Super Fruit" Powders

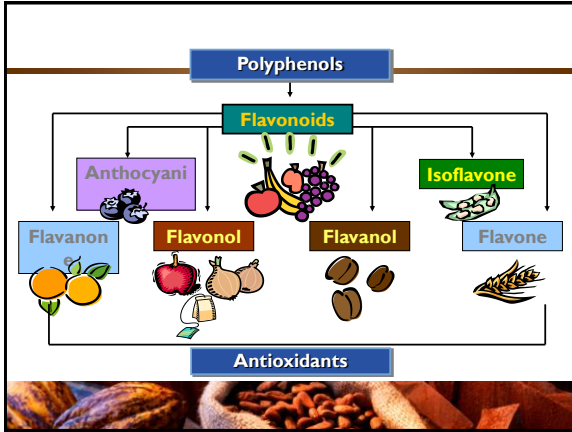


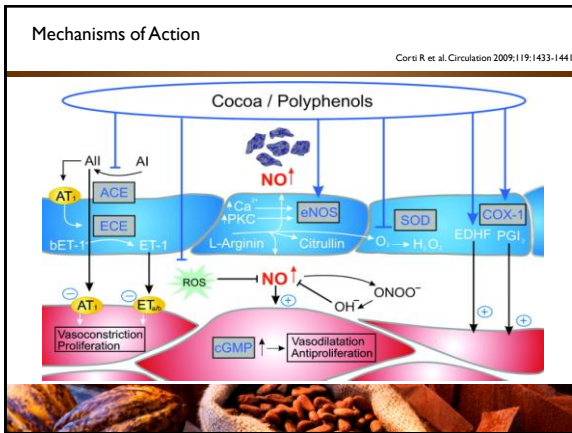
What about foods that people buy?



Antioxidant or Flavanol?

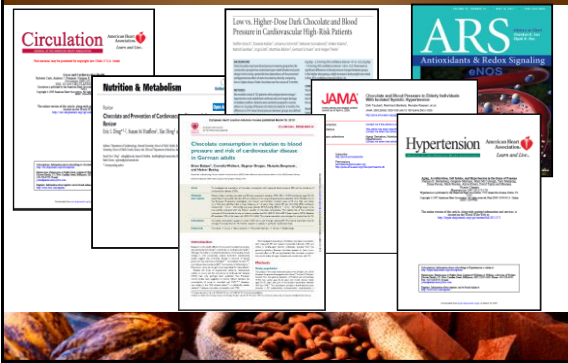






A Review of the Literature

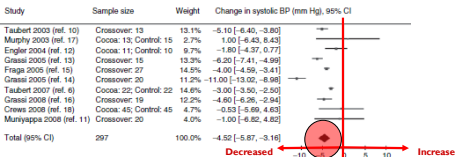
Cocoa & Chocolate Cardiovascular Science is Mounting



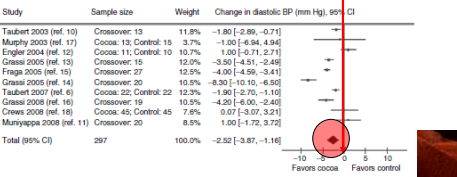
Meta-Analysis Indicates Cocoa & Dark Chocolate Reduce Blood Pressure

Desch et al. Am J Hypertens 2010

Systolic Blood Pressure



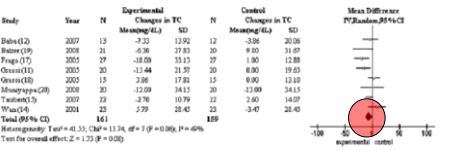
Diastolic Blood Pressure



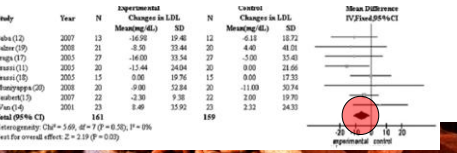
Meta-Analysis Indicates Cocoa & Dark Chocolate Reduce Blood Cholesterol

Jia et al. Am J Clin Nutr 2010

Total Cholesterol

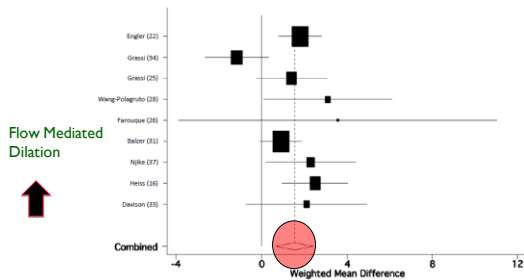


LDL Cholesterol



Meta-Analysis Indicates Cocoa & Dark Chocolate Improve Endothelial Function

Shrime, J Nutr 2012



Inflammatory Markers

Effect of cocoa powder on the modulation of inflammatory biomarkers in patients at high risk of cardiovascular disease⁴

Maria Monagas, Nasiruddin Khan, Cristina Andrea Lacueva, Rosa Casas, Mireia Uribe-Santali, Rafael Llorach, Rosa Maria Lamuela-Raventós, and Ramon Estruch
AJCN. First published ahead of print September 23, 2009

Objective: To evaluate the effects of chronic cocoa consumption on cellular and serum biomarkers related to atherosclerosis in high-risk patients.

Results:

- No significant changes in expression of adhesion molecules on T lymphocyte surfaces
- Monocytes: VLA-4, CD40 and CD36 were lowered with cocoa treatment (p<0.005)
- P-selectin and intercellular adhesion molecule-1 were lowered with cocoa treatment (p<0.007)

Conclusions: These results suggest that the intake of cocoa polyphenols may modulate inflammatory mediators in patients at high risk of cardiovascular disease. These antiinflammatory effects may contribute to the overall benefits of cocoa consumption against atherosclerosis.



2011 Harvard University Review & Cambridge Meta-Analysis

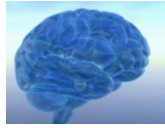
“From an **evidence-based review**, there is **strong evidence** that **high cocoa intake** lowers blood pressure, improves vascular endothelial function (circulation/ blood flow), and potentially increases insulin sensitivity.”

The collage includes a document titled 'Nutrition & Metabolism' with the subtitle 'Characterization and Prevention of Cardiovascular Disease: A Review', a research paper titled 'Effect of Cocoa Consumption on Blood Pressure, Vascular Endothelial Function, and Inflammation: A Meta-Analysis of Short-Term Studies', and another document titled 'Chocolate consumption and cardiovascular disease: systematic review and meta-analysis'.



Emerging Areas of Cocoa & Chocolate Research

- Insulin Sensitivity
- Cognition
- Exercise Recovery



Skin



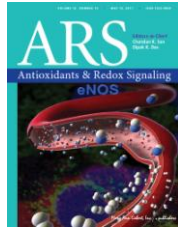
Insulin Sensitivity

✓ There are plausible mechanisms for the antioxidant effects of cocoa polyphenols to influence insulin resistance

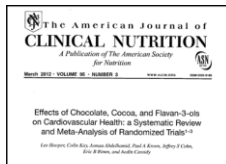
✓ Cocoa...

- may induce pancreatic β -cell regeneration and stimulate insulin secretion
- may have a hypoglycemic effect
- may improve glucose tolerance

✓ Sustained consumption of cocoa over long periods of time may affect insulin resistance to a greater degree than single doses of cocoa products

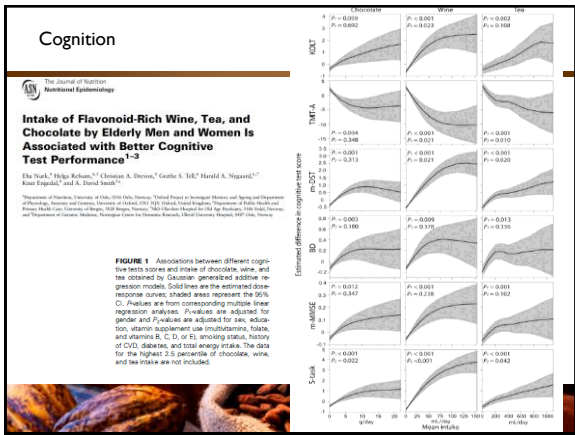
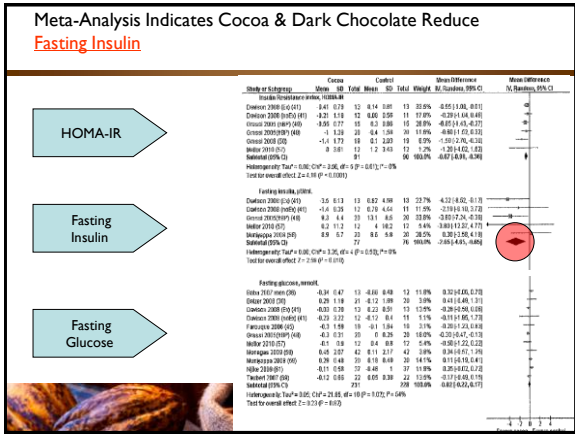


Meta-Analysis of Cocoa & Chocolate finds additional Benefit for Insulin and Glucose Management



Conclusions: We found consistent acute and chronic benefits of chocolate or cocoa on FMD and previously unreported promising effects on insulin and HOMA-IR. Larger, longer-duration, and independently funded trials are required to confirm the potential cardiovascular benefits of cocoa flavan-3-ols. *Am J Clin Nutr* 2012;95:740-51.





Chocolate Milk & Exercise Recovery

Chocolate Milk After Workout: Health Benefits, Muscle Recovery, and More

Jan 31, 2011 - New research suggests that chocolate milk could aid in post-exercise recovery more effectively than other sports drinks, and could have real...

Chocolate Milk After Workout: Health Benefits, Muscle Recovery, and More

Jan 2, 2011 - For chocolate milk fans, our comprehensive sports drink is helping to rebuild and relax muscles after exercise. Researcher report...

Post-Workout Chocolate Milk: Ask!ten

After the gym, treat your muscles to some post-workout chocolate milk. Ask!ten.com's comprehensive guide to the benefits of chocolate milk. Full information on chocolate milk included...

Chocolate Milk After Workout: Rehabilitation, Absorption, and More

Chocolate milk after workout: rehabilitation, absorption, and more...

Chocolate Milk: The New Sports Drink? - CBS News

Feb 24, 2009 - Study Shows Chocolate Milk May Help Athletes' Performance ... sipping of carbohydrates within 30 minutes after a long and rigorous workout...

Exercise Recovery



Objective: To determine if a cocoa-based carbohydrate and protein beverage ingested following exhaustive exercise and would have improvements on subsequent exercise performance 4 hours later.

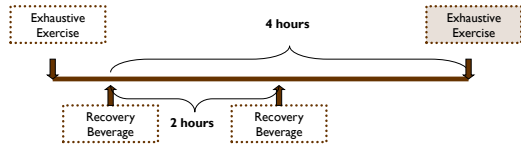
- Subjects consumed the following beverages in a randomized crossover design:
 - Dark Chocolate Milk (High cocoa-flavanol; 3.5:1 CHO:PRO)
 - Vanilla Milk (Low cocoa-flavanol; 3.5:1 CHO:PRO)
 - Cocoa Beverage (High cocoa-flavanol + CHO (no protein))
 - Sports Drink (Low cocoa-flavanol + CHO (no protein))
 - Water
- Total work (KJ) and time to exhaustion were measured during the endurance trial to evaluate exercise recovery.



Exercise Recovery

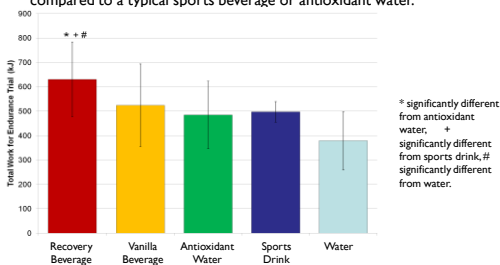


- Study Design:
- 20 Elite cyclists



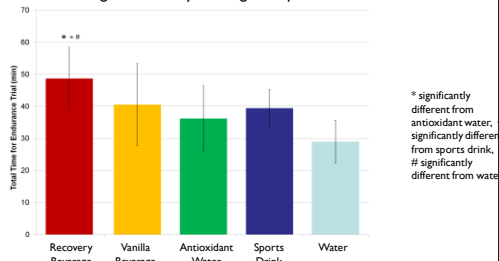
Exercise Recovery: Work

Athletes could do **27% more work** after consuming the recovery beverage compared to a typical sports beverage or antioxidant water.



Exercise Recovery: Time To Exhaustion

Athletes **increased their exercise time to exhaustion by 40%** after consuming the recovery beverage compared to water.



Clinical Nutrition Study: High cocoa-flavanol Recovery Beverage



Objective: The purpose of this study was to:

- Examine the overall efficacy of a cocoa-based protein and carbohydrate drink on perceived muscle soreness and markers of muscle damage and inflammation associated with exhaustive exercise.
- Determine if drink consumption prior to the exercise bout will have additive effects.

■ Subjects consumed the following beverages in a randomized crossover design:

- Cocoa-based CHO/PRO after exercise
- Cocoa-based CHO/PRO before and after exercise
- Control beverage immediately after exercise

■ The Lower Extremity Functional Scale (LEFS) was administered 24 and 48 hours post exercise to determine the participant's level of difficulty with various activities.



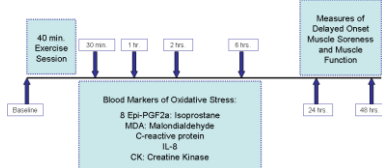
Exercise Recovery: Muscle Soreness



Subject characteristics (n=10):

Age (yrs)	22.9 ± 4.12
Height (cm)	178.91 ± 15.65
Weight (kg)	82.10 ± 10.26
Body Fat (%)	19.11 ± 4.97
VO ₂ max (ml/kg/min)	42.94 ± 4.04

Study Design:

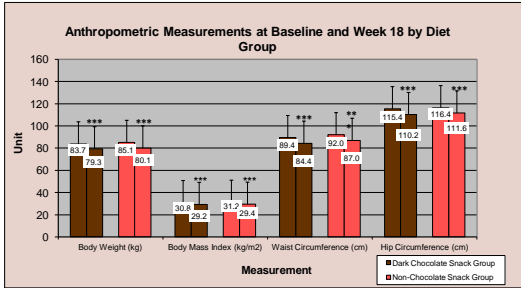


Materials and Methods: Diet Intervention

- | | |
|--|---|
| <p>■ Dark Chocolate Snack Group (N=26)</p> <ul style="list-style-type: none"> - Energy-restricted diet - 50% Carbohydrate - 30% Fat - 20% Protein - 1300 to 1800 kcal/d, individualized for 500 kcal deficit/d | <p>■ Non-Chocolate Snack Group (N=25)</p> <ul style="list-style-type: none"> - Energy-restricted diet - 50% Carbohydrate - 30% Fat - 20% Protein - 1300 to 1800 kcal/d, individualized for 500 kcal deficit/d |
|--|---|



Participants reduced body weight by ~6.6% (~10 pounds) and waist circumference by about 2 inches while including a sweet snack in an energy-restricted diet



*p<0.05, **p<0.01, ***p<0.001; p-value analyzed using paired t-tests for change over time within group and independent t-tests for change over time between groups. Statistically significant differences between diet groups at baseline, week 18 or over time were not found.

Natural Cocoa and Dark Chocolate as Part of a Balanced Lifestyle



Incorporating Natural Cocoa into a Balanced Lifestyle

Incorporating moderate amounts of natural cocoa and dark chocolate as part of a healthy, balanced diet can provide cardiovascular health benefits. (1)



(1) Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010



Incorporating Natural Cocoa and Dark Chocolate into a Balanced Lifestyle

- Results of a research study published in the *Journal of American Medicine* in 2007 showed that eating a small piece of dark chocolate every day significantly reduced blood pressure after 12 and 18 weeks.
- Enjoying one to two tablespoons of natural cocoa a day as an ingredient in beverages, meals or snacks or 20 grams of dark chocolate may support cardiovascular health (2, 3)



(1) Taubert, et al, JAMA 2007
(2) Monahan, et al, J Appl Physiol 2011
(3) Desch S, et al, Am J Hypertens 2010



How to get ~1 Tablespoon Natural Cocoa a day

Cocoa Natural Unsweetened

1 Tablespoon
10 calories
100% Cacao



50% Dark Chocolate

~30 g
100 calories
50% Cacao



70% Bittersweet Chocolate

~30 g
75 calories
70% Cacao