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FILE: ▪ Dark Chocolate (*Theobroma cacao*)
▪ Endothelial Function
▪ Cocoa

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RE: Cocoa and Dark Chocolate Consumption Improves Endothelial Function in Healthy Adults

Faridi Z, Njike VY, Dutta S, Ali A, Katz DL. Acute dark chocolate and cocoa ingestion and endothelial function: a randomized controlled crossover trial. *Am J Clin Nutr*. 2008;88:58-63.

Dark chocolate (*Theobroma cacao*) consumption has been shown to have cardiovascular health benefits, which are attributed to the ability of the flavonoids in chocolate to improve endothelial function by activating the nitric oxide synthase system, providing antioxidant effects, and inhibiting platelet activation and aggregation. An impaired release of nitric oxide causes endothelial dysfunction, i.e., vessels, to constrict and impede flow in response to stimuli that should result in dilatation and flow augmentation. Several studies have also shown that endothelial function is impaired after glucose loading. Endothelial function can be determined noninvasively by inducing hyperemic flow and sheer stress, which stimulates nitric oxide release. High-resolution ultrasound is the standard method used to measure endothelial-dependent flow-mediated dilatation (FMD) of the brachial artery. The authors were unaware of any study that had compared the vascular effects of liquid cocoa with those of dark chocolate or of regular cocoa beverage with sugar-free cocoa; therefore, they compared the acute effects of solid dark chocolate and those of regular and sugar-free liquid cocoa with the effects of placebos on endothelial function and blood pressure in overweight adults.

Healthy men and women were recruited from the Lower Naugatuck Valley area of Connecticut for this randomized, placebo-controlled, single-blind crossover study. Those with an eating disorder, coronary artery disease, diabetes, or sleep apnea were excluded, as were those who were pregnant, were following a restricted dietary regimen, or were allergic to chocolate or cocoa. In phase 1 of the study, 45 subjects were randomly assigned to consume a single dose of either 74 g of a solid dark chocolate bar (containing 22 g of cocoa powder) or 74 g of a placebo bar (containing 0 g of cocoa powder). In phase 2 of the study, the subjects were randomly assigned to consume a single dose of 1 of 6 sequence permutations of sugar-free cocoa (2 cups containing 22 g of cocoa powder, sweetened with small amounts of vanillin, acesulfame-potassium, and aspartame), sugared cocoa (2 cups containing 22 g of cocoa powder, 45.3 g of sugar), or a placebo (2 cups containing 0 g of cocoa powder), each prepared in 240 mL of hot water. The placebos contained slightly more carbohydrates than the solid chocolate (39 g) or the sugared cocoa (104 g). Each treatment was followed by a 7-day

washout period. Blood pressure was measured and endothelial testing and vascular reactivity testing sampling were conducted at baseline (after the subjects fasted overnight) and then 2 hours after each treatment. Endothelial function was measured as FMD.

Forty-four subjects with a mean age of 53 years and an average body mass index of 30 completed the study. One was hypertensive, and 3 were dislipidemic; 4 were on medication that included Lipitor, Avapro, Lotensin, and verapamil. No significant differences in endothelial function and blood pressure were observed at baseline. In Phase 1, consumption of dark chocolate improved FMD more ($4.3 \pm 3.4\%$) than did the placebo ($-1.8 \pm 3.3\%$) ($P < 0.001$). Furthermore, systolic and diastolic blood pressure decreased more after dark chocolate consumption than after placebo consumption ($P < 0.001$). The findings remained the same after adjustment for age, race, body mass index, hypertension, and dyslipidemia. In Phase 2, consumption of sugar-free and sugared cocoa improved FMD ($5.7 \pm 2.6\%$ and $2.0 \pm 1.8\%$, respectively) more than did consumption of the placebo ($-1.5 \pm 2.8\%$) ($P < 0.001$). FMD improved more after consumption of the sugar-free cocoa than after consumption of the sugared cocoa ($P < 0.001$). Furthermore, both systolic and diastolic blood pressure decreased more after consumption of the sugar-free cocoa than after consumption of the placebo ($P < 0.001$). No significant differences in blood pressure were observed after sugared cocoa consumption compared with placebo.

The results suggest that acute ingestion of solid dark chocolate and liquid cocoa significantly improves endothelial function and lowers blood pressure in overweight but otherwise healthy men and women. The effects were significantly greater after consumption of sugar-free cocoa than after consumption of sugared cocoa. The improvement in endothelial function was likely related to elevations in plasma epicatechin concentrations, which increase endothelium-derived vasodilators. However, the failure to measure the plasma catechin concentrations, or to provide equivalent content of magnesium and methylxanthine alkaloids theobromine and caffeine in the placebos as found in the chocolate and cocoa, does not allow the effects to be attributed exclusively or even primarily to the polyphenols, since these other components have potential vasodilating activity as well. Because the antioxidant concentrations of the sugared and sugar-free cocoa preparations were the same, the greater effects observed after consumption of the sugar-free preparation are attributed to the absence of sugar. The authors suggest that future studies are "clearly warranted to determine longer term effects of habitual solid and liquid cocoa ingestion, optimal dosing of chocolate for cardiovascular benefit, variation in beneficial effects among diverse populations, and, ultimately, the influence of dietary cocoa intake on cardiac events."

—Brenda Milot, ELS

The American Botanical Council has chosen not to include the original article.