

## Nutrition and Disease

## Blood Pressure Is Reduced and Insulin Sensitivity Increased in Glucose-Intolerant, Hypertensive Subjects after 15 Days of Consuming High-Polyphenol Dark Chocolate<sup>1-3</sup>,

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Flavanols from chocolate appear to increase nitric oxide bioavailability, protect vascular endothelium, and decrease cardiovascular disease (CVD) risk factors. We sought to test the effect of flavanol-rich dark chocolate (FRDC) on endothelial function, insulin sensitivity,  $\beta$ -cell function, and blood pressure (BP) in hypertensive patients with impaired glucose tolerance (IGT). After a run-in phase, 19 hypertensives with IGT (11 males, 8 females;  $44.8 \pm 8.0$  y) were randomized to receive isocalorically either FRDC or flavanol-free white chocolate (FFWC) at 100 g/d for 15 d. After a wash-out period, patients were switched to the other treatment. Clinical and 24-h ambulatory BP was determined by sphygmometry and oscillometry, respectively, flow-mediated dilation (FMD), oral glucose tolerance test, serum cholesterol and C-reactive protein, and plasma homocysteine were evaluated after each treatment phase. FRDC but not FFWC ingestion decreased insulin resistance (homeostasis model assessment of insulin resistance;  $P < 0.0001$ ) and increased insulin sensitivity (quantitative insulin sensitivity check index, insulin sensitivity index (ISI), ISI<sub>0</sub>;  $P < 0.05$ ) and  $\beta$ -cell function (corrected insulin response CIR<sub>120</sub>;  $P = 0.035$ ). Systolic (S) and diastolic (D) BP decreased ( $P < 0.0001$ ) after FRDC (SBP,  $-3.82 \pm 2.40$  mm Hg; DBP,  $-3.92 \pm 1.98$  mm Hg; 24-h SBP,  $-4.52 \pm 3.94$  mm Hg; 24-h DBP,  $-4.17 \pm 3.29$  mm Hg) but not after FFWC. Further, FRDC increased FMD ( $P < 0.0001$ ) and decreased total cholesterol ( $-6.5\%$ ;  $P < 0.0001$ ), and LDL cholesterol ( $-7.5\%$ ;  $P < 0.0001$ ). Changes in insulin sensitivity ( $\Delta$  ISI -  $\Delta$  FMD:  $r = 0.510$ ,  $P = 0.001$ ;  $\Delta$  QUICKI -  $\Delta$  FMD:  $r = 0.502$ ,  $P = 0.001$ ) and  $\beta$ -cell function ( $\Delta$  CIR<sub>120</sub> -  $\Delta$  FMD:  $r = 0.400$ ,  $P = 0.012$ ) were directly correlated with increases in FMD and inversely correlated with decreases in BP ( $\Delta$  ISI -  $\Delta$  24-h SBP:  $r = -0.368$ ,  $F = 0.022$ ;  $\Delta$  ISI -  $\Delta$  24-h DBP:  $r = -0.384$ ,  $P = 0.017$ ). Thus, FRDC ameliorated insulin sensitivity and  $\beta$ -cell function, decreased BP, and increased FMD in IGT hypertensive patients. These findings suggest flavanol-rich, low-energy cocoa food products may have a positive impact on CVD risk factors.

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