

Chocolatl Verde – Rationale

“Chocolatl Verde” provides, per serving, 15 g cocoa powder, 1 g of a flavanol-rich cocoa extract (with 400 mg flavanols), 15 g of spirulina (with 2.1 g phycocyanin, containing about 100 mg phycocyanobilin), 300 mg of green coffee bean extract (with over 150 mg chlorogenic acid), 180 mg of a soy isoflavone concentrate (over 70 mg isoflavones), and 2 g of the antioxidant amino acid taurine. The product is very low in fat (3 g per serving), high in protein, and contains no added sugar; sweetness is provided by an all-natural non-caloric sugar substitute featuring erythritol (“Zsweet”). Each serving is prepared by blending it into a cup of soy milk or low-fat cow’s milk, or other fluid of your choice. For best health benefits, we recommend 2 servings daily. Its name derives from the Aztec word for chocolate – “chocolatl” (in turn derived from “choco” = foam + “atl” = water), and the fact that the presence of spirulina makes the product intensely green (“verde”). Both chocolate and spirulina – the two main ingredients of this product - are “wonder foods” cultivated by the Aztecs.

A growing number of clinical studies indicate that regular ingestion of flavanol-rich cocoa exerts a range of effects potentially favorable to vascular health – improving endothelial function, reducing elevated blood pressure, increasing insulin sensitivity, and suppressing platelet aggregation.¹⁻¹⁴ There is recent evidence that the epicatechin content of cocoa is primarily responsible for its favorable impact on vascular endothelium, which reflects both an acute and chronic up-regulation of nitric oxide production.^{15, 16} Other research demonstrates that ingestion of flavanol-rich cocoa protects skin from UV damage and has a positive cosmetic impact on the skin of women, increasing its moisture content.¹⁷ The fact that the Kuna Indians of Panama are virtually immune from hypertension and the typical age-related rise of blood pressure, so long as they live a traditional lifestyle, has been traced to their heavy intake of raw cocoa.¹⁰ Moreover, the Kuna appear to be virtually free of stroke.¹⁸ Although the prevalence of senile dementia among the Kuna has not been formally assessed, other Third World cultures in which hypertension and stroke are quite rare are characterized by a near absence of dementia.^{19, 20} An acute increase of brain perfusion has been demonstrated after ingestion of flavanol-rich cocoa.^{21, 22} Moreover, long-term administration of cocoa flavanols to aging rats is associated with preservation of youthful cognitive performance.²³

While spirulina has long been popular as a supplement in “health food” circles, its true merit has only recently been discovered: phycocyanobilin (PCB), the chromophore bound to spirulina’s chief protein, phycocyanin, can function as a potent inhibitor of NADPH oxidase, the enzyme complex that is the chief source of pathological oxidant stress in a wide range of health disorders.^{24, 25} In this regard, it appears to mimic the physiological activity of free bilirubin;²⁶⁻²⁹ PCB can be converted within cells to phycocyanorubin, which is nearly identical in structure to bilirubin.³⁰ Although the clinical utility of ample intakes of spirulina has so far received little research attention, in numerous rodent studies orally administered spirulina or phycocyanin has shown potent anti-inflammatory, cytoprotective, and anti-atherogenic activities; these effects are most likely attributable to down-regulation of NADPH oxidase activity.^{24, 25, 31, 32} A consideration of the central role of NADPH oxidase over-activity in a range of disorders suggests that ample intakes of spirulina may have preventive and therapeutic potential with respect to many vascular diseases (including atherogenesis, hypertension, and congestive heart failure), cancers, complications of diabetes, neurodegenerative disorders, and inflammatory conditions.^{24,}

²⁵ Spirulina also is a source of polysaccharide that has immunostimulant activity (reflecting the activation of TLR2 receptors on macrophages),³³⁻³⁵ and is very rich in zeaxanthin, a dietary carotenoid that has been linked to decreased risk for macular degeneration.³⁶ A recent open clinical trial reports worthwhile reductions in blood pressure and improvements in blood lipid profile in healthy volunteers receiving 4.5 g spirulina daily (a dose far lower than that provided by a full serving of Chocolatl Verde); this suggests that spirulina-bound PCB has good oral bioavailability in humans.³⁷

The antioxidant activity of PCB in the inflamed vasculature should nicely complement the impact of cocoa-derived epicatechin on nitric oxide release. As is well known, superoxide antagonizes the bioactivity of nitric oxide by spontaneously reacting with it to generate the dangerous oxidant peroxynitrite; thus, joint administration of PCB and epicatechin can be expected to optimize nitric oxide's vascular-protective efficacy. PCB and epicatechin may also cooperate in prevention of dementia, by supporting efficient cerebrovascular perfusion while dampening the pathogenic impact of activated microglia.³⁸⁻⁴⁰

High daily intakes of coffee have been linked epidemiologically with a large reduction in risk for diabetes.⁴¹⁻⁴⁴ This effect is not mediated by caffeine, as this protection is also associated with use of decaffeinated coffee. There is reason to suspect that the lignan chlorogenic acid is the component of coffee chiefly responsible for this benefit.⁴⁵ The green coffee bean extract used in Chocolatl Verde is a rich source of chlorogenic acid (over 50%). Chlorogenic acid appears to slow carbohydrate absorption – an effect potentially complementary to that of glucomannan – and to increase intestinal production of the incretin hormone glucagon-like peptide-1 (GLP-1), which aids the efficient function of pancreatic beta cells.^{46, 47} A recent clinical study indicates that daily intakes of chlorogenic acid as low as 140 mg can produce a significant reduction of blood pressure in patients with mild hypertension.⁴⁸ A similar effect is noted in spontaneously hypertensive rats – along with an improvement in endothelial function.⁴⁹ Another recent controlled clinical trial has concluded that chlorogenic acid-enriched coffee can promote weight loss in overweight dieters⁵⁰ – possibly reflecting a favorable effect of increased GLP-1 activity in this regard.⁵¹

The health benefits of soy isoflavones seem to be primarily attributable to the fact that genistein, in the low nanomolar free plasma concentrations that can be achieved with isoflavone-rich diets, acts as a selective agonist for the beta form of the estrogen receptor (ERbeta).⁵² Whereas the alpha estrogen receptor mediates the pro-proliferative and feminizing effects of estrogens, ERbeta typically has anti-proliferative effects in tissues that express it. Agonists specific for ERbeta do not promote breast or endometrial cancer, and do not act on the liver to boost clotting activity; for this reason; they are therefore inherently safer than ERalpha agonists – though they do not provide the same degree of relief from menopausal symptoms that can be achieved with estradiol (they may have a modest impact on “hot flashes”⁵³). ERbeta is expressed by vascular endothelium, and adequate intakes of soy isoflavones or genistein (e.g. about 54 mg genistein daily) have been shown to improve endothelium-dependent vasodilation in postmenopausal women⁵⁴ – an effect, associated with increased nitric oxide production, that may reflect increased expression of the endothelial nitric oxide synthase. The favorable impact of genistein on vascular function possibly accounts for the insulin-sensitizing effect of this nutrient.⁵⁵ Soy isoflavones also help to preserve bone density and slow bone breakdown in postmenopausal

women.^{56, 57} Whether isoflavones can improve vascular function and promote bone density in men requires further study. With respect to cancer, epithelial cells of the prostate and colon express ERbeta, and epidemiological evidence, as well as animal and clinical studies, suggest that soy isoflavones can decrease risk for both colorectal and prostate cancer.⁵⁸⁻⁶⁴ This protective effect may reflect, at least in part, the fact that ERbeta boosts the ability of these tissues to synthesize calcitriol from its circulating precursor, while reducing expression of the enzyme which deactivates calcitriol;^{65, 66} thus, soy isoflavones may enhance the favorable impact of good vitamin D status on cancer risk. In Asian epidemiology, soyfood intake is associated dose-dependently with decreased breast cancer risk,⁶⁷ possibly reflecting a protective role for ERbeta in breast epithelium.^{68, 69} Soy isoflavones also have anti-fibrotic effects, which may reduce risk for hepatic fibrosis, glomerulosclerosis, and left ventricular hypertrophy.^{52, 70}

Taurine functions physiologically to protect tissues from myeloperoxidase-derived oxidants produced in phagocytes (e.g. hypochlorous acid).^{71, 72} It also acts as an osmoregulatory agent, influences intracellular calcium metabolism, and hyperpolarizes certain tissues by activating glycine receptors.⁷³⁻⁷⁵ In rodent studies, dietary taurine has shown anti-hypertensive and anti-atherosclerotic effects;⁷⁶⁻⁸³ taurine pre-loading limits the volume of infarcted tissue evoked by temporary cerebral ischemia, owing to an anti-excitotoxic effect mediated by glycine receptors.⁸⁴⁻⁸⁶ Supplemental taurine has been shown to improve the pumping function of the heart in rodent models of congestive heart failure, and also in human patients with this condition;⁸⁷⁻⁸⁹ this positive inotropic effect reflects taurine's influence on intracellular free calcium. Taurine also has platelet-stabilizing activity that is complementary to that of aspirin.⁹⁰⁻⁹² Limited clinical evidence suggests that the anti-hypertensive impact of taurine observed in rodents may also be clinically relevant.⁹³⁻⁹⁵ Vegetarian diets are devoid of taurine, for which reason vegetarians tend to have poorer taurine status than omnivores;⁹⁶⁻⁹⁸ this may be of some functional importance, as the platelets of vegetarians are more aggregable than those of omnivores.⁹⁸

The chief sweetening agent in Chocolatl Verde is the natural sugar erythritol. This sugar is non-cariogenic, is absorbed efficiently (and thus does not produce the gastric cramping often associated with sorbitol), and is cleared by the kidneys after absorption.⁹⁹⁻¹⁰⁴ Since it is not metabolized, either by humans or human gut bacteria, it is non-caloric.¹⁰⁵ Erythritol has received extensive testing in healthy subjects as well as diabetics, and does not impair diabetic control.¹⁰⁶⁻¹⁰⁸ Toxicological studies have demonstrated that it is very safe.^{100, 109}

Chocolatl Verde (CV) is a food product, and cannot be represented as of proven benefit with respect to prevention or treatment of any disorder. Nonetheless, it has been designed to provide doses of its key ingredients that, on the basis of previous research, can be presumed to be physiologically relevant. For example, the soy flavanol content of CV is intended to mimic the flavanol content of the raw cocoa ingested by the Kuna Indians.¹⁸ Extrapolations from rodent studies suggest that 15-30 g spirulina daily (as provided by one-two servings of CV) may have potent physiological activity in humans.²⁵ The soy isoflavone content has been chosen such that two servings will provide the daily dose of genistein (primarily as its natural precursor genistin) used in the provocative recent clinical studies of Squadrito and colleagues.^{54, 55, 57} The dose of chlorogenic acid in CV has been reported to slow absorption of dietary carbohydrate in

unpublished clinical studies (see www.appliedfoods.com.) Finally, 2-4 g taurine daily (from 1-2 servings of CV) is well within the range that has been evaluated in clinical trials.⁸⁸

As a safe food product, Chocolatl Verde may be used ad libitum. In light of the fact that the excellent vascular health of the Kuna Indians may reflect ingestion of multiple servings of cocoa daily, it may be prudent to use CV twice daily – preferably with meals, so as to exploit the impact of chlorogenic acid on glycemic index. Epicatechin, now suspected to mediate the vascular effects of cocoa, has a rather short plasma half-life following ingestion.¹⁵

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