Product Review: *Cocoa Powders, Dark Chocolate, Extracts, Nibs, & Supplements -- Sources of Flavanols*

Initial Posting: 5/17/14 EXPANDED: 8/1/14 and 10/28/14 Last Update: 3/29/16

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What It Is:
Cocoa powder (also called cocoa solids) is made from cacao beans after removal of the natural fats (cocoa butter). Cocoa powder is rich in antioxidant compounds known as flavanols (also called catechins), which also occur in grapes, apples, and teas. Flavanols can exist as simple compounds (monomers) or linked together (oligomers) as compounds known as proanthocyanidins or PACs -- although both types are often referred to as flavanols, as is in this Review. (Note: Flavanols differ from flavonols, such as quercetin, which contain a ketone group.)

Cocoa powder is used to make cocoa beverages, chocolate, chocolate syrup and chocolate confectionaries. The amount of flavanols in a cocoa-based product depends on multiple factors including plant genetics, how the plant is harvested, how the cocoa is processed, and how the product is prepared. For example, dark chocolate and milk chocolate are made with cocoa powder and cocoa butter, however, dark chocolate has a much higher concentration of flavanols because milk chocolate includes milk, and, typically, a larger amount of sugar. [Be aware that the "% cocoa" or "% cacao" in a chocolate reflects the total amount of cocoa powder plus cocoa butter relative to all other ingredients. As sugar is the only other ingredient in dark chocolate, "% cocoa" in dark chocolate tells you the % which is not sugar. However, as manufacturers typically don't disclose the ratio of cocoa powder to cocoa butter in their chocolates, the "% cocoa" is only a rough indicator of how much cocoa powder is in a product and, therefore, how flavanol-rich the chocolate may be.][Also be aware that the FDA has found milk in some dark chocolates — see Cautions and Concerns].

What It Does:
Cardiovascular:
Populations which consume higher amounts of flavanols from cocoa and other sources tend to have lower rates of **cardiovascular disease**. Most, although not all, studies have shown that the consumption of cocoa flavanols can improve vascular function, and blood-pressure, and raise levels of HDL ("good") cholesterol (see the Encyclopedia article about Chocolate for details). The following are examples of recent studies of cardiovascular effects:

A study in young women in Texas found that daily consumption of 12.7 grams of a natural cocoa bar (containing 309.6 mg of flavanols, including 48 mg of epicatechin) for 4 weeks led to an 18% increase in HDL cholesterol and a 60% decrease in EMPs (particles associated with blood vessel damage). However, additional positive changes in blood markers were seen mainly with obese women and not women of normal weight, suggesting a more positive effect of cocoa on obese women than those who are not obese (McFarlin, J Nutri Biochem 2015).

A small study in Italy, for example, found that within 2 hours of consuming a bar (40 grams) of dark chocolate which was greater than 85% cocoa, people with peripheral artery disease (due to atherosclerosis) were able to walk 15% further than normally; eating a similar amount of milk chocolate had no effect (Loffredo, J Am Heart Ass 2014).

In a study among 100 healthy, middle-aged men and women, consuming a flavored drink twice daily (providing a total of 900 mg cocoa flavanols) for one month resulted in a small, but significant improvement in blood vessel endothelial function (which contributes to normal blood flow) compared to a placebo drink (which contained similar amounts of caffeine and theobromine, but no cocoa flavanols). Those who drank the cocoa flavanol drink also had small but significant reductions systolic and diastolic blood pressure (4.4 mmHg and 3.9 mmHg, respectively) and total and LDL "bad" cholesterol (approximately 8 mg/dL and 7 mg/dL, respectively), as well as a slight increase in HDL "good" cholesterol (about 4 mg/dL). The researchers reported that these changes reduced the estimated risk of death from cardiovascular disease over a projected 10 year period by 30% compared to those who consumed the placebo drink. The flavanol drink, a powder mixed with water and consumed with breakfast and dinner, was made with the same extraction process (called *CocoaPro*) as *CocoaVia* reviewed below and was provided by MARS Inc., which sponsored the study (Sansone, Br J Nutr 2015).

Some evidence suggests that cardiovascular effects of flavanols are due to modulation of nitric oxide concentrations and that these effects may be based on chemical properties other than the antioxidant properties of the ingested compounds.

A study in Finland among people ages 33 to 64 with mild hypertension found that eating dark chocolate (49 grams daily -- 70% cocoa, providing 603 mg flavanols) for 8 weeks had no significant effect on blood pressure or other cardiovascular risk factors (such as arterial stiffness), compared to 8 weeks of refraining from chocolate. During both periods subject were told to reduce snacking — possibly explaining the loss of about 2 lbs during the non-chocolate period of the study, although this did not affect blood pressure. Most other studies with cocoa or dark chocolate have shown modest reductions in blood pressure, although most have been of shorter duration (2 to 4 weeks). (Koli, Nutrition Journal, 2015)

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Although no health claim about cardiovascular benefits can be made on cocoa products in the U.S., in 2012 the European Food Safety Authority granted permission to the maker of a dark chocolate product to claim on its product label that, for the general population, "Cocoa flavanols help maintain endothelium-dependent vasodilation, which contributes to normal blood flow." In order to obtain the claimed effect, 200 mg of cocoa flavanols should be consumed daily. This amount could be provided by 2.5 g of high-flavanol cocoa powder or 10 g of high-flavanol dark chocolate, both of which can be consumed in the context of a balanced diet (EFSA 2012).

Exercise:
A small study in moderately-trained young men given 40 grams of dark chocolate or white chocolate (which lacks flavanols) for 14 days found the dark chocolate resulted in a modest (17%) but statistically significant increase in the distance they could cycle in 2 minutes and reduced the oxygen cost of exercise, suggesting

that it "may be an effective ergogenic aid for short-duration moderate intensity exercise." (Patel, J Int Soc Sport Nutr 2015). The benefit may be due to the ability of epicatechin flavanols to dilate blood vessels by modulating nitrous oxide production. Dove Dark Chocolate was used in the study on the researchers' belief that it had a high concentration of the flavanol epicatechin, but they did not test flavanol levels and it's likely that it actually has a low concentration relative to other products as indicated by other research (Kaspar, U. Wisc. 2006) and the fact that it is only 40% to 50% cocoa (according to Mars Chocolate customer care) and sugar is listed as its primary ingredient.

Memory:
Cocoa flavanols may also help **improve memory**. A study of healthy people ages 50 to 69 found that drinking a high-flavanol hot cocoa drink twice daily (providing a total of 900 mg of flavanols including 138 mg of epicatechin, a type of flavanol) for 3 months enhanced brain functioning as measured by functional MRI and cognitive testing. Compared to people given a similar drink which was low in flavanols (10 mg daily with less than 2 mg of epicatechin), those given the high-flavanol drink improved the speed with which they could recall an image viewed earlier. The increase in speed was just half a second, but researchers likened the faster speed to that of individuals 30 years younger, reversing an aspect of age-related memory decline. Interestingly, the addition of exercise did not improve cognitive scores (Brickman, Nature Neuroscience 2014). The study did not evaluate intermediate doses, so it not known if lower doses of flavanols -- such as the 200 mg suggested for cardiovascular benefit -- might work equally well. The product used in the study was provided by MARS, Inc., maker of the *CocoaVia* powder reviewed below, which provides 250 mg of flavanols per packet. Testing by ConsumerLab.com suggests that the ratio of epicatechin to total flavanols in the product in the clinical study is similar to that in *CocoaVia* and in many other cocoa powders and dark chocolates tested in the Review below, with the exception of *Reserveage CocoaWell,* in which the ratio of epicatechin appears to be significantly higher -- likely due to a contribution of epicatechin from green tea and *Acacia catechu*, which are also listed as ingredients. Some researchers have proposed that cocoa's effect on cognitive function could be the result of increased blood flow to the brain. In a small study of healthy older adults (ages 50 — 65), drinking a high flavanol cocoa drink (494 mg of flavanols including 89 mg of epicatechin) significantly increased blood flow to the brain 2 hours after ingestion, compared to drinking a low flavanol drink (29 mg of flavanols including 3 mg of epicatechin). However, the study did not include tests of cognitive function. The cocoa drinks in this study were also provided by MARS (Lamport, Psychopharmacology 2015).

Another study also showed cognitive benefits, and possible cardiovascular and metabolic benefits, with high-flavanol hot cocoa drinks. In the 2-month study, individuals ages 60 to 85 in general good health were given one of three drinks providing the following amounts of cocoa flavanols: 993 mg (including 185 mg of epicatechin), 520 mg (95 mg epicatechin), or 48 mg (5 mg of epicatechin). Those getting the two higher amounts of flavanols showed moderate improvements in certain aspects cognitive performance — particularly the speed of processing, as well as reductions in systolic and diastolic **blood pressure** (which decreased on average, respectively, by about 5 to 8 and 3 to 5 mm Hg), LDL ("bad") **cholesterol**, and **glucose and insulin** levels — indicating an improvement in glucose metabolism and an association between this and improved cognitive performance (Mastroiacovo, Am J Clin Nutr 2014). An important feature of the study was that cognitive assessments were performed about 24 hours after the final drink was consumed, allowing evaluation of the chronic (rather than immediate) effects of cocoa intake. The drink (a powder mixed with warm water and consumed each morning) was made with the same extraction process (called CocoaPro) as *CocoaVia* reviewed below and was provided by MARS Inc., which sponsored the study.

A placebo-controlled study in Australia of healthy adults ages 18 to 40 given 250 mg of cocoa flavanols (from 3 grams of a cocoa extract in a daily tablet) found it to cause short-term improvement in self-reported mental fatigue and on one mathematical test requiring repeated subtractions, but there was no effect on other aspects of cognitive performance, mood, or cardiovascular functioning either short-term (2 to 3 hours after supplementation) or long- term (after 1 month of daily use). The tablets contained relatively little caffeine (5.6 mg). Interestingly, after 1 month, participants who had been receiving a placebo tablet reported feeling significantly less stressed than those receiving the cocoa flavanols (Massee, Front Pharmacol 2015).

Skin
Cocoa flavanols may have a mild, beneficial effect on facial wrinkles and skin elasticity according to a well-controlled study of 64 women in Korea (average age 67) with moderate sun damage to the skin and visible wrinkles. After 24 weeks of consuming a low-fat cocoa beverage of 4 grams of processed cocoa powder (providing 320 mg of cocoa flavanols) or placebo once daily for 24 weeks, the depth of "crow's feet" **wrinkles** increased by 8 percent among those receiving placebo, but it barely changed in the cocoa flavanol group. **Skin elasticity** improved by about 9% in the cocoa flavanol group, while there was no improvement in the placebo group. There was no significant effect on skin hydration. The women were not permitted consume other foods high in antioxidants around the time of the study. Among a subgroup of the women who were exposed to artificial UV radiation at the end of the study, those who drank the cocoa beverage required a higher dose of radiation to induce skin damage, suggesting cocoa might have a protective effect. The cocoa was provided by Barry Callebaut (Belgium) (Yoon, J Nutr 2015).

Quality Concerns and What CL Tested for:
As noted above, there can be wide variation in the flavanol concentrations of cocoa-based products. In addition, heavy metals can contaminate cocoa plants and cocoa-based products. Consequently, ConsumerLab.com tested a variety of cocoa and cacao products for their amounts of flavanols, as well as for the heavy metals lead, cadmium, and arsenic. Although for many years there was scientific uncertainty about how to properly measure flavanols in cocoa products, in 2012 a validated method, using high performance liquid chromatography, was developed and published by the AOAC International, allowing for more standardized measurement. This is the method utilized by ConsumerLab.com.

For more details about the testing, see How Products Were Evaluated.

Update:

(3/29/16): Independent testing of chocolates by a group in California found that many exceed that state's limits for reproductive harm from lead and cadmium. Some of these products are among those previously tested by ConsumerLab.com in this Review. Details are posted in the Update at the top of the full review.

(1/14/15): ConsumerLab.com was forwarded responses from two more companies about the heavy metals ConsumerLab.com reported finding in their cocoa products. These messages, and our response to them, are now posted in the Update at the top of the full review.

(10/28/14): Due to demand among our readers, ConsumerLab.com tested and added an additional 6 dark chocolate bars to this review.

(8/1/14): Due to demand among our readers, ConsumerLab.com tested and added an additional 6 cocoa powders to this review.

(5/22/14): ConsumerLab.com received copies of letters from the distributors of the two products discovered to be contaminated with cadmium. These letters were sent to concerned customers who forwarded them to ConsumerLab.com.

The distributor of one product has put the product "On Hold" pending that company's review of the data and it acknowledges that the cadmium level is "higher than we prefer." It claims that, based on tests it has performed, cadmium levels in certain of its other cocoa products are very low.

The distributor of the other product states that it feels confident about the safety of its cacao products although it is reevaluating other cacao products available in the marketplace to determine how different supply sources may affect the presence of heavy metals. For details, see the "Update" at the top of the full review.

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