Health Benefits of Dark Chocolate

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ABSTRACT
Chocolate is a raw or processed food produced from the seed of the tropical tree *Theobroma cacao*. Chocolates are increasingly being seen as capable of promoting good health. As these are ideally suited for inclusion in the food matrix of a chocolate bar, complementing the endogenous flavanols, chocolate could be developed as the ideal nutraceutical-polypill delivery system, enhancing health in the form of a tasty treat. Dark chocolate is majorly beneficial in cardiovascular disease. The other health benefits of Dark chocolate includes as antioxidant, improvement in endothelial function, vascular function, insulin sensitivity etc.

Key Words: Dark chocolate, Cocoa, Health, Diet.

INTRODUCTION
Chocolate is a typically sweet, usually brown, food preparation of *Theobroma cacao* seeds, roasted and ground, often flavored, as with vanilla1. It is made in the form of a liquid, paste or in a block or used as a flavoring ingredient in other sweet foods. Chocolate is a range of products derived from cocoa (cacao), mixed with fat (i.e., cocoa butter) and finely powdered sugar to produce a solid confectionery2. Chocolate most commonly comes in dark, milk and white varieties, with cocoa solids contributing to the brown coloration. There are several types of chocolate according to the proportion of cocoa used in a particular formulation3. Dark chocolate, also called black chocolate, is produced by adding fat and sugar to cocoa. It is chocolate with no milk or much less than milk chocolate. Dark chocolate can be eaten as is, or used in cooking, for which thicker, baking bars, usually with high cocoa percentages ranging from 70% to 99% are sold4. Dark is
synonymous with semisweet and extra dark with bittersweet, although the ratio of cocoa butter to solids may vary.

Cocoa products can be very nutritious and the chocolate is the richest source of energy, protein, magnesium, calcium, iron and riboflavin of varying amounts, essential for mental health and heart function. The cocoa seeds are rich in copper, sulphur and vitamin C. Dark chocolate is naturally rich in flavonoids. These compounds are thought to lower blood pressure and protect against heart disease-among other things. Recent studies conducted both in the U.S. and Europe seem to support chocolate’s beneficial effects on the cardiovascular system, encouraging chocolate manufacturers to develop proprietary methods of processing cocoa beans aimed specifically at preserving flavonoid content. Traditional roasting and fermentation methods are thought to destroy up to three-quarters of these compounds.

Different types of chocolate contain different amounts of theobromine. In general, theobromine levels are higher in dark chocolates (approximately 10 g/kg) than in milk chocolates (1-5 g/kg). Higher quality chocolate tends to contain more theobromine than lower quality chocolate. Cocoa beans naturally contain approximately 300-1200 mg/ounce theobromine.

**PHYSICAL PROPERTIES**

The most common form of cocoa butter has a melting point of around 34–38°C (93–101°F), rendering solid chocolate at room temperature that readily melts once inside the mouth. Cocoa butter displays polymorphism, having α, γ, β' and β crystals, with melting points of 17, 23, 26, and 35–37°C respectively. The production of chocolate typically uses only the β crystal for its high melting point. A uniform crystal structure will result in smooth texture, sheen and snap. Overheating cocoa butter converts the structure to a less stable form that melts below room temperature. Given time, it will naturally return to the most stable β crystal form. Advantage is taken of this phenomenon in the polymorphic transformation theory of chocolate bloom. It is based on the fact that bloomed chocolates are always found to contain the most stable polymorph of cocoa butter. The Refractive index of cocoa butter is 1.44556-1.44573. Its Iodine value is 32.11-35.12, 35.575. Acid value is 1.68. Saponification value is
191.214, 192.88-196.29. It has a Food energy value of 3,770 kilojoules per 100g (3.5oz).

CHEMISTRY

Cocoa contains more than 300 volatile compounds, the most important components are aliphatic esters, polyphenols, aromatic carbonyls and theobromine, which also prevent rancidity of the fat\textsuperscript{11}. The pharmacologically active ingredients of cocoa seeds include amines, alkaloids theobromine (0.5\% to 2.7\%), caffeine (approximately 0.25\% in cocoa), theophylline, fatty acids, polyphenols (including flavonoids), tyramine, trigonelline, magnesium, phenylethylamine and N-acylethanolamines. A standard chocolate bar (40 to 50 g) contains theobromine (86 to 240 mg) and caffeine (9 to 31 mg). The characteristically bitter taste of cocoa is generated by the reaction of diketopiperazines with theobromine during roasting. Theobromine is produced commercially from cocoa husks. Cocoa butter contains triglyceride fatty acids consisting mainly of oleic, stearic and palmitic acids. It also contains myristic, arachidic, lauric, palmitic, linoleic, α-linolenic acids. Cocoa is rich in polyphenols that have beneficial effects on cardiovascular disease. In cocoa, the polyphenols of particular interest are flavanols, a subclass of flavonoids, which are in turn a subclass of polyphenols. Cocoa is more than 10\% flavanol by weight. Flavonols can be monomeric in cocoa beans these are mainly (−)-epicatechin and (+)-catechin, dimeric (consisting of 2 units of epicatechin with differing linkages) or polymeric (combinations of monomers and chains of up to 10 units or more have been found)\textsuperscript{12}. These polymers are known as procyanidins\textsuperscript{13}.

MECHANISM

Cocoa has been reported to be a source of natural antioxidants, the free radical scavengers that preserve cell membranes, protect DNA, prevent the oxidation of low-density lipoprotein (LDL) cholesterol that leads to atherosclerosis and prevent plaque formation in arterial walls. The antioxidant activity of cocoa has been attributed to the procyanidins and their monomeric precursors, epicatechin and catechin, which inhibit oxidation of LDL\textsuperscript{14}. Dark chocolate and cocoa inhibit LDL oxidation and increase high-density lipoprotein (HDL)-cholesterol concentrations. Catechin and
Epicatechin has been found in cocoa. Catechins are phytochemical compounds found in high concentrations in a variety of plant-based foods and beverages. The catechin content in dark chocolate is 12 mg/100 gm. The epicatechin content in dark chocolate is 41.5 mg/100 gm. The consumption of catechins has been associated with a variety of beneficial effects including increased plasma antioxidant activity, bronchial artery dilation, fat oxidation and resistance of LDL to oxidation\(^1\). Epicatechin seems to be a major bioactive constituent of cocoa and other flavonol-rich foods and beverages\(^2\). It has been shown to improve endothelial function in animals and humans\(^3\). In salt-sensitive animal models of hypertension, epicatechin lowers blood pressure and the associated end-organ damage. Nitric oxide seems to play a key role in the protection of both hypertension and endothelial dysfunction. The antioxidant capacity of dark chocolate is 13.1/100 g.

**HEALTH BENEFITS OF DARK CHOCOLATE**

Dark chocolate has recently been discovered to have a number of healthy benefits. The various health benefits of dark chocolate includes, alleviation of cardiovascular disease, protection against heart disease, stroke prevention, alleviation of hypertension (high blood pressure), regulation of blood sugar and insulin dependence, reduced risk of type II diabetes, antioxidant protection, alleviation of cold and cough, reduced cancer risk, reduced risk of colon cancer, slowing aging, increased immune function, slowing the progression of AIDS, DNA repair and protection, alzheimer’s protection, alleviation of premenstrual syndrome, prevention of alopecia\(^4\).

**For cardiovascular disease**

Research suggests that the chocolate, cocoa and flavan-3-ols are used for the prevention of cardiovascular disease\(^5\). Consumption of foods rich in flavanols are also associated with improved cardiovascular outcomes, suggesting that this specific group of flavonoids may have potent cardioprotective qualities\(^6\). Dark chocolate may reduce the risk of atherosclerosis by thickening and hardening of the arteries and by restoring flexibility of the arteries and preventing white blood cells from sticking to the blood vessel walls\(^7\). The possible mechanism of these flavonoids may include
reducing the oxidative stress, increasing the endothelial prostacyclin release, enhancing the endothelial function\textsuperscript{22}, increasing the sensitivity of insulin receptors, inhibiting the lipid oxidation and inhibiting angiotensin-converting enzyme\textsuperscript{23}.

**For cardiometabolic disorder**

In general the cardiometabolic disorders exert a burden on people\textsuperscript{24}. However, these are largely preventable. By systematic review and meta-analysis the cocoa products containing flavonol have a potential to prevent cardiometabolic disorders\textsuperscript{25,26}.

**As cardiorespiratory stimulant**

Theobromine, the primary alkaloid in cocoa, is a weak CNS stimulant, with only one-tenth the cardiac effects of other methylxanthines (e.g., caffeine, theophylline). Theobromine has activity similar to that seen with caffeine (i.e., increases in energy, motivation to work and alertness). Theobromine, when ingested in the form of a large chocolate bar, did not cause any acute hemodynamic or electrophysiologic cardiac changes in young, healthy adults\textsuperscript{27}. Theobromine pharmacokinetics were similar in healthy men when measured after 14 days of abstention from all methylxanthines and then after 1 week ingestion of dark chocolate (theobromine 6 mg/kg/day). Hence, the results of these studies cannot be extrapolated to patients with any conditions or diseases or to the effects of chronic chocolate consumption.

**For endothelial and vascular function**

Dark chocolate induced a rapid and significant improvement of endothelial and platelet function in healthy smokers 2-8 hours after ingestion\textsuperscript{28-30}. Cigarette smokers exhibit increased atherogenic potential, as they consistently have endothelial and platelet dysfunction, which are associated with an increased cardiovascular risk\textsuperscript{31}. These findings are mediated by the antioxidant effect of polyphenol-rich dark chocolate. Hypertension and excess body weight are important risk factors for endothelial dysfunction. Recent evidence suggests that high-polyphenol dark chocolate improves endothelial function and lowers blood pressure in stage 1 hypertension\textsuperscript{32}. Hence consumption of chocolate bars resulted in reductions in systolic and diastolic blood pressure.

**For blood sugar**

Dark chocolate helps blood vessels healthy and circulation unimpaired to protect against
type II diabetes. The flavonoids in dark chocolate also help to reduce insulin resistance by helping cells to function normally and regain the ability to use body's insulin efficiently\textsuperscript{33}. Dark chocolate also has a low glycemic index and it won't cause huge spikes in blood sugar levels.

**For brain**

Dark chocolate increases blood flow to the brain as well as to the heart, so it can help to improve cognitive function\textsuperscript{34}. Dark chocolate contains several chemical compounds that have a stimulant action and positive effect on the mood and cognitive health\textsuperscript{35}. Chocolate contains phenylethylamine (PEA), PEA encourages brain to release endorphins and feel alert. Dark chocolate also contains caffeine, a mild stimulant. However, dark chocolate contains much less caffeine than coffee and hence ingredients of chocolate were used in mood disorders\textsuperscript{36}.

**For oral hygiene**

Dark chocolate contains theobromine, which has been shown to harden tooth enamel. That means that dark chocolate lowers the risk of getting cavities in proper dental hygiene. Theobromine is also a mild stimulant, though not as strong as caffeine. It can, however, help to suppress coughs. Theobromine works by suppressing the activity of the vagus nerve, which causes coughing and cures the cough.

**As antioxidant**

Dark chocolate is loaded with antioxidants. Antioxidants help against free radicals, which cause oxidative damage to cells\textsuperscript{37}. Free radicals are implicated in the aging process and may be a cause of cancer, so eating antioxidant rich foods like dark chocolate can protect the body from many types of cancer and slow the signs of aging\textsuperscript{38}.

**As vitamins and minerals**

Dark chocolate contains a number of natural vitamins, minerals and nutrients that can support the health. Dark chocolate contains proteins, saturated fat, calories, vitamins like vitamin B1, vitamin B2, vitamin B3, vitamin B9, vitamin K, calcium, dietary fiber, magnesium, phosphorous, manganese, selenium, iron, potassium, copper and zinc. The copper and potassium in dark chocolate help prevent against stroke and cardiovascular ailments. The iron in chocolate protects against iron deficiency anemia and the magnesium in chocolate
helps prevent type II diabetes, high blood pressure and heart disease.

**In magnesium deficiency**
In rats, the magnesium contained in cocoa has been shown to prevent and correct chronic magnesium deficiency. Low intakes of magnesium may be responsible for some cardiovascular alterations as well as renal, GI, neurological and muscular disorders. The use of cocoa to treat or prevent magnesium deficiency in humans has not been explored\(^{39}\).

**For cognitive performance**
Free radical damage has been implicated as a cause of cognitive decline and memory loss in aging. A study using functional magnetic imaging in healthy young people found that ingestion of flavonol-rich cocoa was associated with increased cerebral blood flow, suggesting that cocoa may play a role in the treatment of cerebral impairment, including dementia and stroke.

**In cancer**
Data suggest that flavonoid-rich food contributes to cancer prevention. An *in vitro* study showed that breast cancer cells are selectively susceptible to the cytotoxic effects of cocoa-derived pentameric procyanidin and suggest that inhibition of cellular proliferation by this compound is associated with the site-specific dephosphorylation or down-regulation of several cell cycle regulatory proteins\(^{40}\).

**CONCLUSION**
Chocolate is a high calorie, high fat food. Dark chocolate is naturally rich in flavonoids. These compounds are thought to exhibit different therapeutic activities. The major benefit of dark chocolate is in cardiovascular related disorders. The various other benefits of dark chocolate includes, alleviation of hypertension, regulation of blood sugar, antioxidant protection etc.

**REFERENCES**
4. Pucciarelli DL, Grivetti LE. The medicinal use of chocolate in early North


improves endothelial and platelet function. Heart; 2006; 92: 119-120.


40. Ramljak D, Romanczyk LJ, Metheny-Barlow LJ. Pentameric procyanidin from...