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## Dark chocolate: Consumption for human health

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**Abstract**

Chocolate/cocoa has been known for its good taste and effects on human health for centuries. Chocolate is a raw or processed food preparation from the seed of the *Theobroma cacao* (tropical plant). Cocoa seed contains more phenolic antioxidants than most foods and food preparations. It contains flavonoids, including catechin, epicatechin, and procyanidins, which are predominate in antioxidant activity. Antioxidant effects of cocoa may directly influence insulin resistance and, in turn, reduce risk for diabetes. Further, cocoa consumption may involve in gene expression and the immune response. Cocoa can protect nerves from injury and inflammation, protect the skin from oxidative damage from UV radiation in topical preparations and have benefit to satiety, cognitive function and mood. Cocoa is predominantly consumed as energy-dense chocolate and potential detrimental effects of overconsumption exist, including increased risk of weight gain. The health benefits of Dark chocolate includes as antioxidant, improvement in endothelial function, vascular function, insulin sensitivity and it is majorly beneficial in cardiovascular disease. Dark chocolate could be developed as the ideal enhancing human health in the form of a tasty treat.

**Keywords:** Dark chocolate, cocoa, health, *Theobroma cacao*

**Introduction**

Chocolate is a food preparation of seeds of tropical plant *Theobroma cacao*. For the preparation of chocolate the seeds of *Theobroma cacao* were roasted and ground and often flavored as with vanilla flavour (Vishal P, Shivendra Kumar D and Yusuf Ali J, 2012) [1]. It is available in different forms includes a block, liquid or paste. Chocolate is also used as a flavouring agent in other sweet food preparations. Varieties of chocolate includes dark, milk and white varieties depends on proportion of cocoa used in a particular formulation (Lee R and Balick M, 2005) [2]. The products of Cocoa can be very nutritious and it is the richest source of energy, protein, magnesium, calcium, iron and riboflavin of different amounts. It is essential for mental health and heart function (Cooper KA *et al.*, 2008) [3]. The seeds of cocoa are rich in copper, sulphur and vitamin C.

Dark chocolate is naturally rich in flavonoids (Arts IC, Hollman PC and Kromhout D, 1999) [4]. These compounds are thought to lower blood pressure and protect against heart disease-among other things (Buijsse B *et al.*, 2006) [5].

**History of Chocolate**

Chocolate came to Europe in the 16th century. Since then, the modern chocolate industry has developed, and cocoa seeds are now processed in different ways. Chocolate is the most commonly craved food in the world (Weingarten HP and Elston D, 1991) [6].

In the past, due to health effects of chocolate, it was considered the drink of Gods, thus the scientific name of the cocoa tree give rise, *Theobroma cacao*, from the Greek words 'theo' means 'God' and 'broma' means 'drink'.

The *Theobroma cacao* tree and its dried seeds are prior to processing are called 'cacao' in American English; after processing, i.e. roasting and grinding, the term 'cocoa' is used. And the 'Chocolate' is the food which is prepared from roasted seeds of cacao.

**Chemical Compounds in Chocolate which May Affect Human Health**

The nutritional qualities of chocolate have been studied by several authors and some people have called it as a complete food. Cocoa contains more than 300 volatile compounds; the most important components include aliphatic esters, polyphenols, aromatic carbonyls and theobromine ([http://en.wikipedia.org/wiki/Cocoa\\_butter](http://en.wikipedia.org/wiki/Cocoa_butter)). Important chemical compounds found in chocolate are as follows.

**Fats**

The fat predominantly found in dark chocolate in the form of cocoa butter (Kris-Etherton PM, Mustad V and Derr J, 1993) [9] which contains approximately 33% oleic acid has positive

effect on lipid level (monounsaturated), 25% palmitic acid (saturated) and 33% stearic acid (saturated) (USDA National Nutrient Database <http://www.nal.usda.gov/>).

### Antioxidants

Cocoa contains large amounts of flavonoids, procyanidins, catechin, and epicatechin (Natsume M *et al.*, 2000)<sup>[11]</sup>. It has maximum levels of flavonoids, more than tea and wine (Lee KW, 2003)<sup>[12]</sup>. Dark chocolate contains considerably higher amounts of flavonoids than white and milk chocolate (Vinson JA, Proch J and Zubik L, 1999)<sup>[13]</sup>. Moreover, the biological effects of flavonoids may also be greater in dark chocolate (Serafini M *et al.*, 2003)<sup>[14]</sup>.

### Minerals

Cocoa seeds contain minerals such as potassium, phosphorus, copper, iron, zinc, and magnesium, which have potential to the health benefits of chocolate (Ashton J and Ashton S, 2003)<sup>[15]</sup>.

### Nitrogenous compounds

The proteins and the methylxanthines, theobromine and caffeine are including as nitrogenous compounds of cacao. They give an important role in central nervous system stimulants, diuretics, and smooth muscle relaxants (R. Latif, 2013)<sup>[8]</sup>.

### Pharmacologically Active compounds

The pharmacologically active compounds of cocoa seeds contain caffeine (approximately 0.25% in cocoa), amines, alkaloids theobromine (0.5% to 2.7%), theophylline, fatty acids, polyphenols (including flavonoids), tyramine, trigonelline, magnesium, phenylethylamine and N-acyl ethanolamines. A standard chocolate bar (40 to 50 g) contains theobromine (86 to 240 mg) and caffeine (9 to 31 mg) (A. Lakshmana Rao *et al.*, 2014)<sup>[31]</sup>.

### Physical properties of Chocolate

The melting point of most common cocoa butter is around 34–38°C (93– 101°F), rendering chocolate is solid at room temperature and that readily melts once inside the mouth. Cocoa butter displays polymorphism, having  $\alpha$ ,  $\gamma$ ,  $\beta'$  and  $\beta$  crystals, with melting points of 17, 23, 26, and 35–37°C respectively. The production of chocolate typically uses only the  $\beta$  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  $\beta$  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) (A. Lakshmana Rao *et al.*, 2014)<sup>[31]</sup>.

### Health Benefits of Dark Chocolate

#### For cardiovascular disease

Many researchers suggest that the chocolate and cocoa are used for the prevention of cardiovascular disease (Hooper L *et al.*, 2012)<sup>[16]</sup>. Consumption of foods which are rich in flavanols are also associated with improved cardiovascular

outcomes which suggest that this specific group of flavonoids may have potential to cardio protective qualities (Fisher ND and Hollenberg NK, 2005)<sup>[17]</sup>. Dark chocolate may reduce the risk of athero-sclerosis by thickening and hardening of the arteries and by restoring flexibility of the arteries and preventing white blood cells from sticking to the walls of blood vessel (Mink PJ, Scrafford CG and Barraja LM, 2007)<sup>[18]</sup>. The possible mechanism of these flavonoids may include reducing the oxidative stress, increasing the endothelial prostacyclin release, enhancing the endothelial function, increasing the sensitivity of insulin receptors, inhibiting the lipid oxidation and inhibiting angiotensin- converting enzyme (Erdman JW *et al.*, 2008; Engler MB and Engler MM, 2006)<sup>[19, 20]</sup>.

#### As cardiorespiratory stimulant

Theobromine is the primary alkaloid in cocoa and it is a weak central nervous system stimulant, with only one tenth the cardiac effects of other methylxanthines (e.g., caffeine, theophylline). Theobromine has similar activity with caffeine (e.g., increases in energy, motivation to work and alertness). When theobromine ingested in the form of a large chocolate bar it did not cause any acute hemodynamic or electrophysiologic cardiac changes in young and healthy adults (Mumford GK, Evans SM and Kaminski BJ, 1994)<sup>[21]</sup>.

#### For endothelial and vascular function

Recent evidence suggests that high-polyphenols present in dark chocolate improves endothelial function and reduces blood pressure in stage 1 hypertension. Hence consumption of chocolate bars resulted in reductions in systolic and diastolic blood pressure (Nogueira LP *et al.*, 2012)<sup>[22]</sup>.

#### For cardiometabolic disorder

By systematic review and data analysis the cocoa products containing flavanol have a potential to prevent cardiometabolic disorders (Lopez AB *et al.*, 2011; Taubert D, Roosen R and Schomog E, 2007)<sup>[23, 24]</sup>.

#### In cancer

Recent evidence and data suggest that flavonoids 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 (Ramljak D, Romanczyk LJ and Metheny-Barlow LJ, 2005)<sup>[25]</sup>.

#### As antioxidant

Dark chocolate is rich in antioxidants, which help against free radicals, which cause oxidative damage to cells (Waterhouse AL, Shirley JR and Donovan JL, 1996)<sup>[26]</sup>. Free radicals are implicated in the aging process and may be a cause of cancer, so eating dark chocolate (rich in antioxidants) can protect the body from many types of cancer and slow the signs of aging (Keen CL *et al.*, 2005)<sup>[27]</sup>.

#### As vitamins and minerals

Recent evidence suggests, dark chocolate contains a number of natural vitamins, minerals and nutrients that can support the human health. It contains proteins, saturated fat, calories, and vitamins like vitamin B1, vitamin B2, vitamin B3, vitamin B9, vitamin K, calcium, magnesium, phosphorous,

manganese, selenium, iron, potassium, copper and zinc. In dark chocolate the copper and potassium helps to prevent against stroke and cardiovascular ailments. The iron in dark chocolate protects against iron deficiency in anemia and the magnesium in dark chocolate helps to prevent type II diabetes, high blood pressure and heart disease (A. Lakshmana Rao *et al.*, 2014)<sup>[31]</sup>.

### Effects of dark chocolate consumption on human health

#### Effects on inflammation

Researchers suggests anti-inflammatory effects on the lipoxigenase pathway, the chocolate flavonoids have been reported to decrease inflammation via several mechanisms, including inhibition of nitrogen induced activation of T cells, polyclonal activation of B cells and reduced secretion of interleukin-2 (IL-2) by T cells (Sanbongi C, Suzuki N and Sakane T, 1997)<sup>[30]</sup>.

#### Neurological effects

Data analysis on dark chocolate suggests the, consumption of dark chocolate increases blood flow to the brain as well as to the heart, so it can help to improve cognitive function (Di Tomaso E, Beltramo M and Piomelli D, 1996)<sup>[28]</sup>. It contains several chemical compounds that have a stimulant action and positive effect on the mood and cognitive health (Small DM *et al.*, 2001)<sup>[29]</sup>.

#### Effects on oral hygiene

Dark chocolate contains theobromine, which has been shown to harden tooth enamel. That means it lowers the risk of getting cavities in proper dental hygiene. It is also a mild stimulant, though not as strong as caffeine. It can, help to suppress coughs (A. Lakshmana Rao *et al.*, 2014)<sup>[31]</sup>.

#### Effects on 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 (Grassi D *et al.*, 2005)<sup>[32]</sup>. Dark chocolate also has a low glycemic index and it won't cause huge spikes in blood sugar levels (A. Lakshmana Rao *et al.*, 2014)<sup>[31]</sup>.

### Conclusion

Dark chocolate is a high calorie and high fat food preparation and it is naturally rich in flavonoids. The major benefit of dark chocolate is in cardiovascular related disorders. The various other benefits of dark chocolate include alleviation of hypertension, regulation of blood sugar, antioxidant protection, for endothelial and vascular function etc.

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