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Impact of cocoa on the human health

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Abstract

Humans have consumed foods made from beans from the Theobroma cacao tree for centuries. Already Aztec warriors supported the cocoa powder drink before the battle. In modern society, chocolate has been known for its good taste. Earlier, chocolate used to be criticized for its fat content and its consumption was a sin rather than a remedy, associated with acne, caries, obesity, high blood pressure, coronary artery disease and diabetes. However, the recent discovery of biologically active phenolic compounds in cocoa has changed this perception[14]. Flavonoids, including catechin, epicatechin, and procyanidins predominate in antioxidant activity.

Nowadays, in many studies discuss the recent progresses on potential health benefits of cocoa, with a focus on the areas that have been paid little attention so far, such as the role of cocoa in immune regulation, inflammation, neuroprotection, oxidative stress, obesity, and diabetes control[12].

The purpose of this review is to interpret research done in the last decade on the benefits of chocolate consumption.

Key words: cocoa; flavonols; chocolate

Introduction and purpose:
Chocolate is made from cacao, which comes from the seeds of the *Theobroma cacao*tree. Cacao tree is from the equatorial region from Central and South America, but it thrives also in Africa and Indonesia The cocoa tree blooms and bears fruit the whole year round, which means that cocoa has flowers and fruit on the tree at the same time. Pure cacao is not a sweet snack. Seeds from the cacao tree are extremely bitter, which is a pretty effective survival strategy for *Theobroma cacao*. Chocolate is the most frequently craved food, has an uniquely attractive taste and might even be beneficial for health. The popularity of this food appears to be mainly due to its potential to arouse sensory pleasure and positive emotions[6,10,17,31].

According to a review of chocolate's health effects published in the *Netherlands Journal of Medicine,*cocoa, the key ingredient in chocolate, contains biologically active phenolic compounds. This has changed people's views on chocolate, and it has stimulated research into how it might impact aging, and conditions such as oxidative stress, blood pressure regulation, and atherosclerosis [14].

Description of the stage and knowledge:

MOST SIGNIFICANT COMPONENTS OF COCOA AND CHOCOLATE

Amount Per Serving	
Calories 155	Calories from Fat 80
	% Daily Value*
Total Fat 8.9g	14%
Saturated Fat 5.3g	27%
Trans Fat 0g	
Polyunsaturated Fat 0.3g	
Monounsaturated Fat 2.7g	
Cholesterol 2.3mg	1%
Sodium 6.8mg	0%
Potassium 158mg	5%
Total Carbohydrates 17g	6%
Dietary Fiber 2g	8**%**
Sugars 14g	
Protein 1.4g	
Vitamin A	0.3%
Calcium	1.2%
Iron	13%

Table 1. Nutrition facts – dark chocolate 1oz (28g)
* Percent Daily Values are based on a 2000 calorie diet.

Lipids

Cocoa or cacao, is fermented and dried fatty seed of the fruit od the cocoa tree, *Theobroma cacao.*

Lipids are main components of cocoa butter. They make 50-57% of the dry weight of cocoa beans. High concentration of lipids result in melting properties of chocolate [33]. In chocolate it is possible to find saturated, as well as unsaturated fatty acids. Saturated ones are predominant and these are stearic acid (up to 35%) and palmitic acid (up to 25%). Monounsaturated fatty acids (mainly oleic acid) represent approximately 3% of all fatty acids. The rarest are polyunsaturated fatty acids. The studies have proven that chocolate-enriched diet doesn't affect LDL-cholesterol levels [9, 13]
In seed of cocoa tree it is possible to find small amounts of sterols (mainly sitosterol and stigmasterol). These chemical particles resemble human cholesterol, and thanks to this similarity they can inhibit cholesterol absorption in intestine. On the other hand sterol's levels in chocolate products may be too low to have any significance [20, 25].

Fiber
The content of fiber in cocoa based products strongly varies. The processing can significantly lower the amount of bran of cocoa and thus lower the amount of fiber [11]. Dark chocolate usually contains more fiber than milk chocolate. 100g portion of dark chocolate contains approximately 13g of fiber. Soluble fiber is known for reducing serum cholesterol and maintaining body weight. Insoluble fiber has been associated with reduced risk of type 2 diabetes [35]. The main type found in cocoa is insoluble fiber.
Minerals
Cocoa is a relevant source of minerals. Especially dark chocolate can provide considerable amounts of them. It contains approximately 36mg of magnesium per 100kcal. This mineral is very important for correct muscle relaxation, protein synthesis and energy production [34]. In comparison milk chocolate delivers 3 times less magnesium. Chocolate can be a good source of cooper as well. It is a cofactor for many enzymes and takes part in iron transport, glucose metabolism, infant growth and brain development [26]. 100-kcal serving of dark chocolate provides 31% of daily recommended dietary allowance (RDA). Next important mineral that is present in cocoa is potassium. The level of potassium in chocolate isn't especially high (114mg/100kcal in dark chocolate, which makes 2% of RDA). Dark chocolate is a good source of iron (1,9mg/100kcal). This mineral is essential for oxygen transport.

Polyphenols
Cocoa powder contains up to 50 mg of polyphenols per gram. The most important of polyphenolic compounds, that are present in cocoa, are flavonoids especially flavanols. These compounds form complexes with salivary proteins and are responsible for bitter taste [24]. The content of flavanols in chocolate strongly varies. It can be lowered by aggressive processing or masked by other flavors. Dark chocolate contains approximately 5 times more flavanols than milk chocolate. These

compounds provide strong antioxidant effect, with procyanidins providing the majority of it. Other important flavanols are epicatechin and catechin [28]. In chocolate there are also present: methylxanthines, mainly theobromine, and caffeine, but in small amounts.

Type of product	% fat	Total polyphenols	Epicatechin (mg/g)	Catechin (mg/g)
Cocoa powder	15.0 (5.8)	52.4 (7.5)	1.854 (0.849)	0.578 (0.285)
Baking chocolate	52.6 (0.7)	27.7 (1.3)	1.142 (0.103)	0.491 (0.222)
Dark chocolate	34.7 (5.5)	13.0 (1.7)	0.336 (0.031)	0.164 (0.064)
Semisweet chocolate chips	28.9 (1.0)	12.4 (0.6)	0.483 (0.085)	0.194 (0.071)
Milk chocolate	32.6 (4.0)	4.4 (1.1)	0.099 (0.067)	0.043 (0.038)
Chocolate syrup	0.9 (0.3	4.2 (0.6)	0.074 (0.046)	0.042 (0.015)

Table 2. Polyphenol Content and Antioxidant Capacity of Selected Commercially Available Cocoa Products. Adapted from *Miller et al.* Values are presented as means and standard deviations [24]

Other components

Another important component for chocolate properties is tryptophan and derived from it serotonin. Serotonin is known as “happiness hormone”. In addition it regulates peristalsis [4].

For many years cocoa has been criticized for its negative impact on health. These include, among others, acne, caries, obesity, high blood pressure and diabetes. However, the latest studies show positive effects on ageing, blood pressure regulation and arteriosclerosis [14].

Flavonols- polyphenols contained in cocoa, have beneficial impacts on endothelium. They cause vasodilatation by stimulating nitric oxide-synthase, increasing availability of L-arginine and decreasing degradation of nitric oxide [8]. Futhermore, cocoa may decrease oxidative stress and platelets aggregation. Moreover, it reduces circulation markers related to impaired coagulation (von Willebrand factor, factor VIII and fibrinogen), reduces inflammation mediators (tissue necrosis factor-α, interleukin-6, interleukin-10, and C-reactive protein) and also decreases insulin sensitivity [14,16].

The Zupthen Elderly Study has proved that there is a link between cocoa intake and blood pressure. The group with a high cocoa intake (more than 2,3g daily) was compared with the group of a small intake (less than

0,36g daily). The results proved that high cocoa intake significantly decreased the diastolic blood pressure that is associated with lower cardiovascular mortality [5,12]. Cocoa consumption may decrease the risk of coronary heart disease by 5% and the risk of global mortality by 4% [16]. Animal studies showed that flavonols stimulate mitochondrial biogenesis, prevent mitochondrial permeability transition pore opening and reduce superoxide production. These effects decrease cardiac post-ischemic damage [5].

Glucose and lipids profile that are factors for/in? vascular damage are also regulated by cocoa flavonols. They modulate insulin secretion in β-pancreatic cells and target insulin-sensitive tissues. Furthermore, flavonols enhance glucose uptake and decrease glucose production [23]. Flavonols also regulate carbohydrate absorption in the gut, improve insulin sensitivity in peripheral tissues, exert a lipid-lowering effect, prevent the exacerbated oxidative stress and inflammation, increase HDL level and decrease LDL level. All these actions are significant factors in improving insulin-sensitivity and help in maintaining normoglycemia which lead to nutritional prevention of diabetes mellitus type II. However, it is important to mention that many commercially available food products contain low amount of flavonols but they are rich in sugar and calories and they should be limited in diabetes mellitus type II nutrition [29].

Cocoa flavonols have also positive effects on central nervous system, among others on Alzheimer's disease. In vitro studies have proved that flavonols are not only antioxidants but also support neuroprotection. They cause non-amyloidogenic breakdown of amyloid precursor proteins and remove neurotoxic Aβpeptides [19]. An experimental study showed that cacao also provides beneficial effects by reducing hyperglycemia and cholinesterase activity in the hippocampal tissue [18]. Moreover, cocoa flavonols increase cerebral blood flow that has a protective effect in dementia and stroke [32]. Ingredients of chocolate cause analgesic effect by releasing β-endorphins in the hypothalamus [27].

Experimental studies suggest an association between cocoa intake and changes in lymphoid organs. It leads to thymocyte differentiation and increases amount of splenic B and T cells in rats. Flavonols maintain a proper level of TGF-β1 production, which if decreased can lead to otherwise lead to cardiac fibrosis and if increased to arteriosclerosis [19, 21]. Flavonols may also increase IL-5 level, that stimulates IgA production, which reduces the risk of caries and periodontal diseases [22]. Moreover, digestion of cocoa polyphenols in the small intestine stimulates growth of *Lactobacillus* spp. and *Bifidobacterium*, that are responsible for the activation of Treg cells and the production of IL-10, thus having an anti-inflammatory effect [19].
Cocoa through oral or topical intake may protect human skin from harmful UV effects. It is caused by components of cacao, that have

antioxidant, anti-inflammatory and photoprotective impacts on the skin. Antioxidants have a significant role in preventing premature skin ageing by decreasing oxidative stress. Cocoa also increases the blood flow of cutaneous and subcutaneous tissues and increases the skin density and hydration. Therefore, chocolate that is rich in cocoa, can be used as an anti-aging agent for a treatment and prevention of skin diseases [30].

Summary:
Cacao, the quintessential ingredient in all true chocolate and cocoa products, is a highly complex food source [12].
Since flavonols exhibit a bitter taste, manufacturers have established processing techniques for cocoa, which eliminate the bitterness together with flavonoids [8]. As much as 90% of the flavonoids may be lost due to cocoa processing. Thus, it needs to be established whether the consumption of products with lower polyphenol content are associated with any health benefits in humans.

According to researchers at Loma Linda University Adventist Health Sciences Centre in Southern California, in addition to making people happier from the sugar, consuming dark chocolate can have a positive effect on brain health.
However, it is important to remember that it is only dark chocolate that has a “positive impact on cognition, memory, mood, immunity and other beneficial effects,” according to Dr. Lee S. Berk (School of Allied Health Professions and a researcher in psychoneuroimmunology and food science from Loma Linda University) [15].
The benefits of chocolate consumption must be weighed against the at-least theoretical risk of weight gain. Food can be medicine, and chocolate may be a noteworthy example. However, potential in this area will not be fully realized until or unless parameters for prescription are established [12].

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