Cocoa and chocolate consumption – Are there aphrodisiac and other benefits for human health?

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Abstract

Cocoa and chocolate have been acclaimed for several years for their possible medicinal and health benefits. It is only recently, however, that some of these claims have been more clearly identified and studied. Recent epidemiological and clinical studies, for example, have shown that dietary supplementation with flavonoid-rich cocoa and chocolate may exert a protective effect on low-density lipoprotein (LDL) oxidation, which has been associated with a reduced risk of developing atherosclerosis. Some of the identified benefits of flavonoid-rich cocoa and chocolate include antioxidant properties, reduced blood pressure via the induction of nitric-oxide (NO)-dependent vasodilation in men, improved endothelial function, increased insulin sensitivity, decreased platelet activation and function, as well as modulated immune function and inflammation. Furthermore, chocolate has been reported to release phenylethylamine and serotonin into the human system, producing some aphrodisiac and mood-lifting effects. Since these claims could have implications for the consumption levels of cocoa and chocolate products on the global market, understanding the critical factors involved and their potential benefits are currently thought to be of great importance to consumers.

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Introduction

"Cocoa" is a corrupted word for cacao, which is taken directly from the Mayan and Aztec languages. Chocolate is derived from cocoa beans, central to the fruit of the tree *Theobroma cacao* (Figure 1). *Theobroma* (from the Greek for "food of the gods") are of the family Sterculiaceae. They comprise two principal types: Criollo, constituting about 5% of the world's cocoa production, and the more common Forastero, which has smaller, flatter, purple beans. A third variety, Trinitario (a more disease-resistant hybrid of Criollo and Forastero), is regarded as a flavour bean.[1]

Theobroma cacao grows between the tropics of Cancer and Capricorn, with varieties originating in the forest areas of South America. Forastero – basic cocoa – grows mainly in Brazil and West Africa, while the flavour cocoas (largely hybrids), thrive in Central and South America.

The Aztecs in Mexico cultivated cocoa from South America via the Caribbean Islands and Hernandos Cortés, a Spanish took cocoa to Spain as a beverage and to Spanish Guinea as a crop.

West Africa currently produces more than 70% of the world's cocoa, with production dominated by the Ivory Coast (39%), Ghana (21%), Nigeria (6%) and Cameroon (5%).[2]

The use of cocoa beans dates back at least 1 500 years, when the Aztecs and Incas used the beans as currency for trading or to produce so-called chocolatl, a drink made by roasting and grinding cocoa nibs, mashing them with water and often adding other ingredients such as vanilla, spices and honey.[3] In the 1520s, the drink was introduced to Spain[4], although Coe and Coe[5] emphasise that the European arrivals in the New World, including Christopher Columbus and Herman Cortes, were unimpressed with the Mayan beverage and therefore sweetened it with honey. The conquistadors nevertheless familiarised the chocolate beverage throughout Europe but, being expensive, it was initially reserved for consumption by the highest social classes. It was only in the 17th century that the consumption of chocolate spread through Europe. In 1847, Joseph Fry was the first to produce a plain eating chocolate bar in the United Kingdom, made possible by the introduction of cocoa butter as an ingredient.[4] Demand for cocoa then sharply increased and chocolate processing became mechanised with the development of cocoa presses for the production of cocoa butter and cocoa powder by Conrad J van Houten in 1828, milk chocolate by Daniel Peters in 1876 after Henri Nestlé's invention a decade earlier, and the conche process by Rodolphe Lindt in 1880.[3] Chocolate confectionery is now ubiquitous, with consumption averaging 8,0 kg per person per annum in many European countries.[6]

Cocoa and chocolate products have recently attracted the attention of many investigators and the general consuming public because of their potential nutritional, medicinal and mystical properties. Chocolate is a very complex food and scientists continue to investigate it in order to unlock its potential benefits and secrets. When consumed, for example, it has been observed to have effects on human behaviour and health. Over the past decade, several studies have also reported that its consumption can contribute to the attainment of optimal health and development as well as play an important role in reducing the risk or delaying the development of chronic disease, such as cardiovascular disease (CVD), cancer and other age-related disease.[7,8,9]

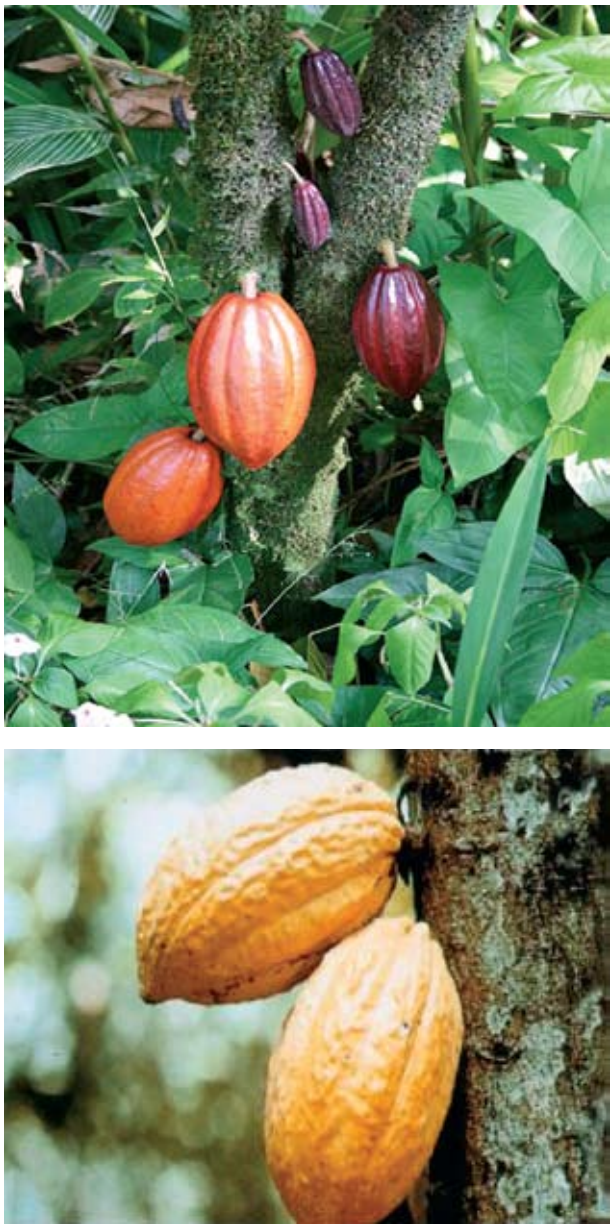


Figure 1: Typical cocoa trees with fruit pods at various stages of ripening

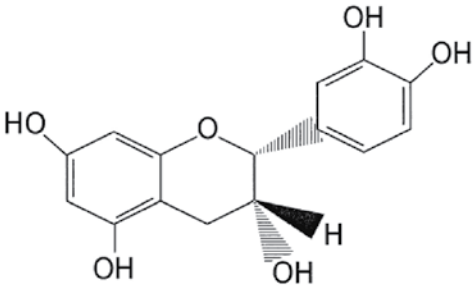
Recently, chocolate has gained a reputation as an aphrodisiac, as is the case with lobster, crab legs, pine nuts, walnuts, alcohol and Viagra. In most parts of the world, chocolate is also associated with romance – and not without good reason, as it was viewed as an aphrodisiac by the Mayan and Aztec cultures, which believed that it invigorated men and made women less inhibited.[10] The reputed aphrodisiac qualities of chocolate are, however, most often associated with the simple sensual pleasure of its consumption. Additionally, chocolate's sweet and fatty nature is reported to stimulate the hypothalamus, which induces pleasurable sensations and affects the levels of serotonin in the brain[11], hence enhancing sexual drive.[12] Finally, chocolate has been shown to contain unsaturated N-acylethanolamines, which may activate cannabinoid receptors in humans or increase endocannabinoid levels, resulting in heightened sensitivity and euphoria.[12]

Over the past decade, however, associations between chocolate consumption and hypertension, diabetes, sexual weakness and CVD have also grown steadily, appearing to be supported by basic, clinical and epidemiological research. As the approach to treating these diseases is through pharmacological agents, lifestyle adjustment and dietary modification, the identification of foods with aphrodisiac qualities and/or cardiovascular health benefits and the understanding of how these food components influence normal human physiology could hold a promise of benefit for the consumer.

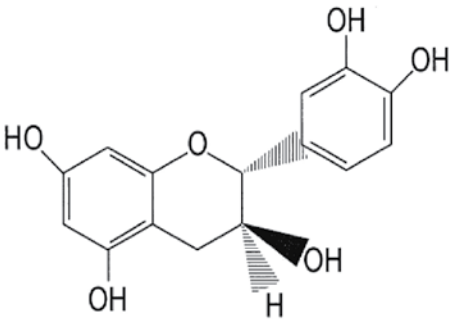
This review discusses current information relating to the acclaimed aphrodisiac and other beneficial health implications of cocoa and chocolate consumption based on epidemiological, preclinical and clinical studies conducted over the past decade.

Chemistry and composition of cocoa flavonoids

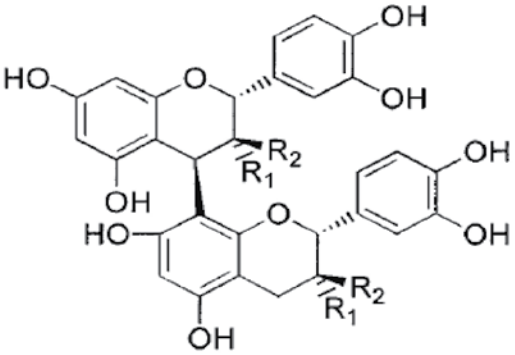
Cocoa and its derived products – chocolate and cocoa powder – are rich in flavonoids, which are characterised as flavan-3-ols or flavanols, and include the monomeric forms, (-)-epicatechin and (-)-catechin, and the oligomeric form of the monomeric units, the procyanidins (Figure 2).[9,13,14]



(-)-epicatechin



(+)-catechin



procyanidin (4β->6) dimers

Figure 2: Chemical structure of the major cocoa flavanols: (-)-epicatechin and (+)-catechin, and procyanidin

These flavonoids are stored in the cotyledon pigment cells of the cacao bean, the fruit of the cacao tree (*Theobroma cacao*), and are differentiated into three main groups: catechins or flavan-3-ols (about 37%), anthocyanins (about 4%), and proanthocyanidins (about 58%). Less abundant is (+)-catechin, while only traces of (+)-gallocatechin and (-)-epigallocatechin are present. The anthocyanin fraction is dominated by cyanidin-3-α-L-arabinoside and cyanidin-3-ß-D-galactoside. Procyanidins are mostly flavan-3,4-diols and are 4-to-8 or 4-to-6-bound to form dimers, trimers or oligomers, with epicatechin as main extension sub-unit.[15,16]

The flavonoids represent a ubiquitous and abundant group of polyphenols consumed in the diet primarily from fruits, vegetables and/or plant products. They act as antioxidants due to their free radical scavenging properties, their ability to reduce the formation of free radicals and their ability to stabilise membranes by decreasing membrane fluidity.[17,18] These antioxidant properties may contribute to the mounting evidence that a diet rich in fruits and vegetables reduces the risk of CVD.[9] Metabolic and epidemiological studies indicate that the regular intake of such products increases the plasma level of antioxidants, a desirable attribute as a defence against reactive oxygen species (ROS). The antioxidants in cocoa can also prevent the oxidation of low-density lipoprotein (LDL) cholesterol, which is related to the mechanism of protection in heart disease. Few studies, however, have shown that ROS associated with carcinogenic processes is also inhibited.[14,19,20] The fats from cocoa (cocoa butter) are moreover mainly stearic triglycerides (C18:0), which are less well absorbed than other fats and tend to be excreted in the faeces. They are thus less bioavailable and have a minimal effect on serum cholesterol.[9,13]

Many investigators have identified the common classes and food sources of flavonoids as including flavanol (quercetin, kaempferol and myricetin [in onions, apples, tea and red wine]), isoflavones (daidzein and genistein [in soy]), flavan-3-ols or flavanols (catechin and epicatechin [in tea, chocolate and red wine]), flavanones (naringenin and hesperitin [in citrus fruits]), flavones (apigenin [in celery], luteolin [in red pepper]) and anthocyanins (in the pigments of red fruits, such as berries and red grapes).[14] These different classes of flavonoids are based on their level of oxidation in the basic flavonoid structure (C6-C3-C6), a 15-carbon atom structure arranged in three rings (two aromatic rings on the ends with an oxygenated heterocycle in the middle). Evidence from epidemiological studies suggests that a high intake of dietary flavonoids may reduce the risk of coronary heart disease.[13,21,22] Flavonoids have also been reported to have benefits for oxidative stress, vascular function, platelet function and immune response, which may collectively be involved in the process of atherogenesis.

Chocolate types and their major nutritional constituents

Chocolate is a dense suspension of solid particles, with an average solids concentration of about 60 to 70% from sugar, cocoa and milk (depending on the type) dispersed in a continuous fat phase, which consists mostly of cocoa butter. The main chocolate categories are dark, milk and white (Figure 3), differing in their content of cocoa solid, milk fat and cocoa butter. The outcome is varying proportions of carbohydrate, fat and protein content (Table I).

Table I: Major constituents of dark, milk and white chocolate[23]

Product	Carbohydrate (%)	Fat (%)	Protein (%)
Dark chocolate	63.5	28.0	5.0
Milk chocolate	56.9	30.7	7.7
White chocolate	58.3	30.9	8.0

Cocoa refers to the non-fat component of cocoa liquor (finely ground cocoa beans) used in chocolate manufacture in the form of cocoa liquor (containing about 55% cocoa butter) or cocoa powder (about 12% fat), with the addition of sugar, cocoa butter and/or milk. Apart from chocolate, other cocoa products include cocoa powder consumed as a beverage, which is very popular in most African countries. Despite the varied chemical contents, cocoa and chocolate consumption makes a positive contribution to human nutrition through the provision of the macronutrients for energy and other metabolic functions. Chocolate also contains minerals, specifically potassium, magnesium, copper and iron. In addition, cocoa and chocolate fat contain many fatty acids, which are triglycerides dominated by saturated stearic, palmitic and monounsaturated oleic[24,25] and all of which appear to have a neutral effect on blood-lipid levels. They do not, in other words, raise blood-cholesterol levels.

The antioxidants in cocoa, principally polyphenols including flavonoids such as epicatechin, catechin and notably the procyanidins, are also thought to provide added medicinal and health benefits. White chocolate, however, differs from milk and dark through the absence of cocoa solids, which contain antioxidants, and thus makes little or no contribution to the potential polyphenol-induced improvements in human health. It is also important to note that most dark chocolate contains higher amounts of antioxidant cocoa flavanols than does milk chocolate.

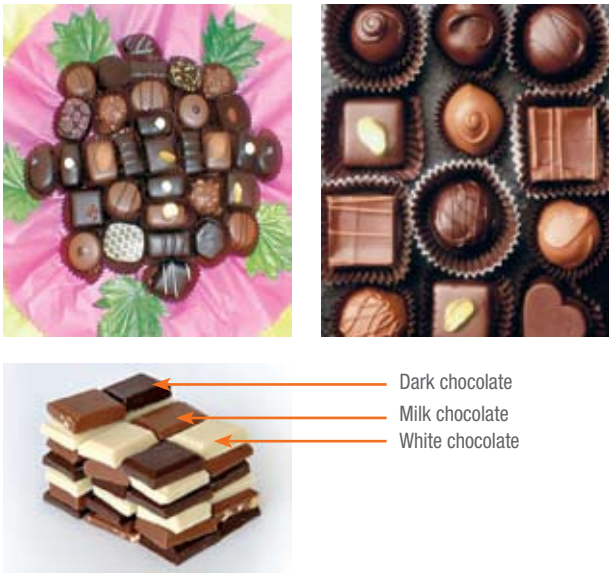


Figure 3: Packs of chocolates containing mixtures of the major types (dark, milk and white)

A 40-g serving of milk chocolate, for example, provides 394 mg of cocoa flavonoids, whereas dark chocolate contains 951 mg. A hot cocoa mix, in contrast, contains 45 mg of cocoa flavonoids in a 240-mL serving.[14,22] These numbers represent typical cocoa flavonoid concentrations and depend on the chocolate-processing

methods, which may reduce or retain the amount of flavonoids derived from the cacao bean. Judging from reported research on cocoa and chocolate, milk chocolate has been less of an object of investigation than dark (black) chocolate. The reason for this is that the amounts of polyphenols in milk chocolate are smaller than in dark chocolate due to the lower amount of cocoa liquor used in milk chocolate (about 10±15%) compared with that of dark chocolate (about 30±50%). In addition, milk proteins, especially caseins, which are relatively proline-rich, may impair the absorption of procyanidins due to complexation.[13] Dark chocolate thus seems a priori to have higher potential as being the most beneficial to human health.

Antioxidant properties and their mechanism of action

Cocoa powder and chocolate have been shown to have antioxidant potential and to inhibit LDL oxidation *in vitro*.[26] Studies show that the ingestion of a single bolus of cocoa or chocolate increases the antioxidant capacity of plasma, decreases the formation of plasma 2-thiobarbituric acid-reactive substances (TBARS), increases insulin sensitivity and inhibits LDL oxidation *ex vivo*.[26–30] Recent evidence suggests that the long-term consumption of cocoa polyphenols also increases the antioxidative capacity of plasma.[31] Studies dealing with the effects of the long-term consumption of chocolate on lipid peroxidation *in vivo*, however, are scarce and therefore warrant further investigation.

Several approaches have been used to investigate the mechanism of the action of cocoa flavanoids. These include preclinical, clinical and *in vitro* studies predominantly for their effects on the vascular system, with nitric acid (NO) concentration being the central target (Figure 4), and for their effects on endothelial function*, which are thought to be a good biomarkers for estimating coronary-disease risk.[9] *In vitro* cocoa procyanidins have been shown to be antioxidative and to be chelators of copper and iron, thereby preventing LDL from oxidising. Procyanidins also inhibit cyclo-oxygenase 1 and 2 (COX-1 and COX-2) and lipoxygenase. By enhancing the levels of NO, which has been identified as the endothelial-derived relaxing factor and is derived from constitutive endothelial nitric oxide synthase, procyanidins could cause vasodilatation.[13] Romanczyk and co-workers[16] suggest that, although the polyphenolic compounds inhibit the oxidation of LDL, the more comprehensive consequence is their multidimensional effects on atherosclerosis via NO. The beneficial effects of NO modulation include the regulation of blood pressure and the lowering of NO-affected hypercholesterolaemia and monocyte adhesion, all of which are involved in the progression of atherosclerosis.

Many clinical trials have also shown improved epithelial function after chocolate consumption, with neutral effects on total serum cholesterol.[14,32–34] Other effects related to CVD risk include the inhibition of platelet activation and aggregation.[35–37] This is due probably to the high content of stearic acid (~30% of fatty acids), which is considered to be neutral with respect to total and LDL cholesterol.

The consumption of cocoa or dark chocolate may also benefit serum lipids. In a recent study, the consumption of cocoa with dark chocolate increased the serum concentration of high-density lipoprotein (HDL) cholesterol by 4% as a result of the antioxidant properties of flavonoids, which may account partially for the protective effect. The oxidative modification of LDL also plays an important role in atherogenesis. Agents that can prevent LDL oxidation in the arterial wall have furthermore been noted to delay the onset of atherosclerosis in humans.[9,33,35]

* Lipoprotein oxidation, platelet aggregation and inflammation

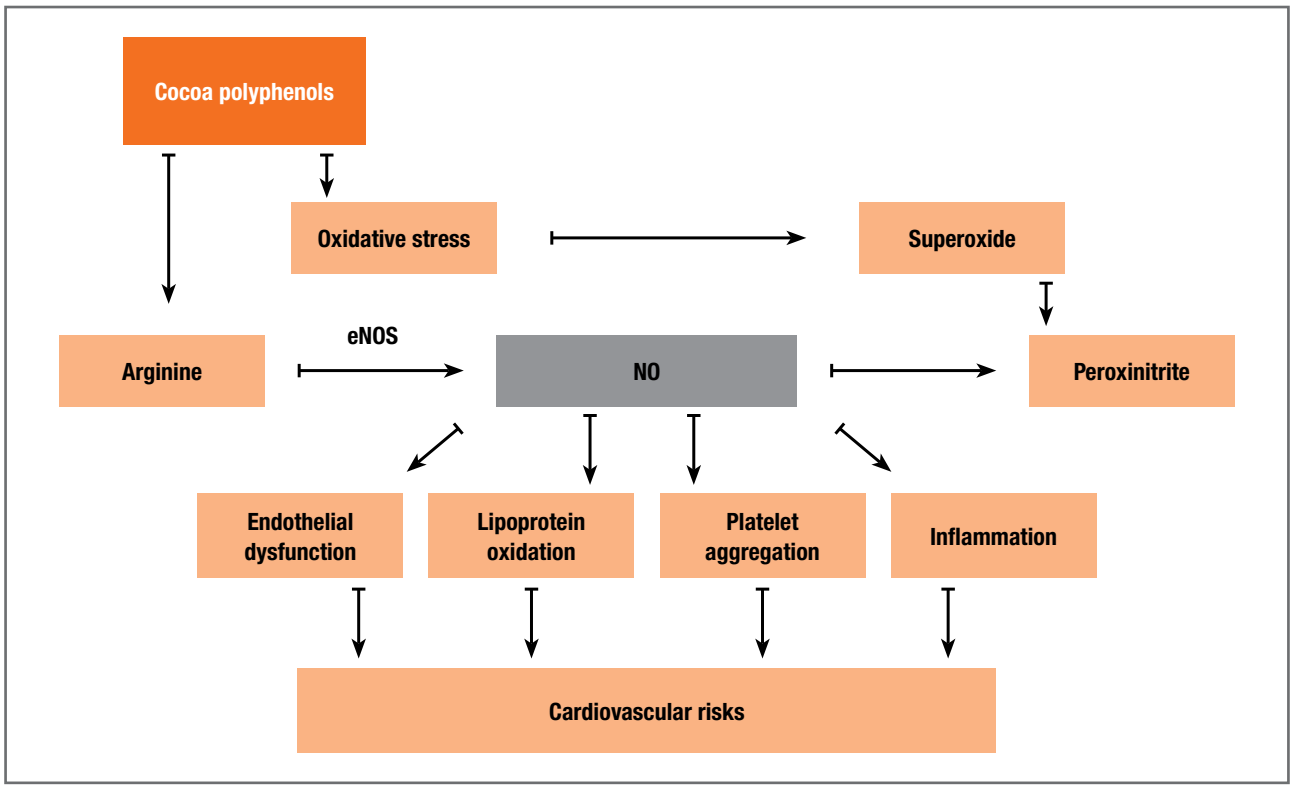


Figure 4: Role of cocoa polyphenols on the vascular system, with nitric oxide (NO) as the target (eNOS = endothelial nitric oxide synthase)[9]

Effects on endothelial function, blood pressure and the cardiovascular system

Investigators have recently focused on flavan-3-ols as bioactive compounds, particularly with respect to their beneficial effects on endothelial function, blood pressure and cardiovascular function. Many of these studies report that cocoa and chocolate consumption is associated with short-term improvement in the delayed oxidation of LDL cholesterol[31], with improved endothelial function[34,38], with lowered blood pressure[39], with increased insulin sensitivity[30] and with improved platelet function.[36,37,38] A recent 15-year epidemiological study of elderly Dutch men showed that blood pressure was significantly lowered in the group consuming cocoa or chocolate. The group with the highest cocoa and chocolate consumption was also reported to have a lower incidence of death due to CVD compared with men who did not consume cocoa or chocolate.[40] Taubert and colleagues[41] also state that small amounts of commercial cocoa confectionary conveyed similar blood pressure-lowering potential compared with comprehensive dietary modifications that have a proven efficacy to reduce cardiovascular-event rate. They explain that, whereas long-term adherence to complex behavioural change is often low and requires continuous counselling,[42,43] the adoption of small amounts of flavanol-rich cocoa in the habitual diet is a dietary modification that is easy to adhere to and that therefore may be a promising behavioural approach to lower blood pressure in individuals with above-optimal blood pressure.

Although chocolate and cocoa consumption is reported to have benefits for lipid peroxidation *ex vivo* and for the serum concentration of HDL,[14,17] very few long-term studies on effects on lipid peroxidation *in vivo* have been published. Previous studies have shown that the concentration of serum HDL cholesterol and the oxidative modification of LDL play an important role in the pathogenesis of atherosclerosis,[15,37–40] with reports that the consumption of cocoa or chocolate may benefit both these factors in humans. In many of these studies, the consumption of cocoa and dark chocolate was reported to increase the concentration of HDL cholesterol and plasma antioxidant capacity[31,44,45] and to decrease the formation of lipid oxidation products (TBARS).[44,45]

In another study, Mursu and colleagues[47] found that the concentration of HDL cholesterol increased in healthy humans ingesting chocolate that contained cocoa mass. The increase in HDL cholesterol was 11% after the consumption of dark chocolate and 14% after the consumption of dark chocolate enriched with cocoa polyphenols, whereas no effect was observed after the consumption of white chocolate. The ratio of LDL:HDL also changed in a similar manner, suggesting that, because the fatty-acid content in the study chocolates was identical, it was the compounds in the cocoa mass that were responsible for the increase in HDL cholesterol.

Data documenting the benefit on HDL concentration are supported by a recently reported, long-term crossover study. In this study, Wan and colleagues[31] found that, after the daily consumption of 22 g of cocoa powder and 16 g of dark chocolate for four weeks, the concentration of HDL cholesterol was 4% higher compared with the control diet (an average American diet). The higher amount of chocolate ingested (75 g or the equivalent of two candy bars) may explain the greater increase in the HDL cholesterol (11 to 14%) reported by Mursu and colleagues.[47] A high concentration of HDL cholesterol has been shown to decrease the risk of CVD.[48] The concentration of HDL cholesterol can usually also be increased by 10 to 15% through a change in lifestyle behaviour but this strategy is not suitable for everyone, since it can be meaningfully achieved only by vigorous exercise or moderate alcohol consumption.[49]

The consumption of chocolate also significantly inhibited the oxidation of LDL *in vivo*, as measured in the formation of conjugated dienes. The decrease in LDL peroxidation in these study groups indicates the likelihood of this effect being due to the fatty acids in chocolate. It has previously been reported that, compared with polyunsaturated fatty acids, monounsaturated fatty acids inhibit lipid peroxidation.[50–53] A high consumption of saturated or monounsaturated fat in the form of chocolate may thus modify the lipid content of LDL to make it more resistant to oxidation by increasing the amount of monounsaturated and saturated fats and by decreasing the amount of polyunsaturated fatty acids.

Effects on insulin sensitivity and carcinogenic properties

Cocoa and dark-chocolate consumption has been claimed to protect the vascular endothelium by augmenting NO availability and thereby improving endothelium-dependent vasorelaxation.[54-57] In an attempt to expand on these findings, Grassi and colleagues[30] studied the effects of the consumption of either dark or white chocolate on the homeostasis model assessment of insulin resistance and the quantitative insulin sensitivity check index in 15 healthy young adults with typical Italian diets. These diets were supplemented daily with 100 g of dark chocolate or 90 g of white chocolate, each of which provided 480 kcal. The polyphenol contents of the dark and white chocolate were assumed to be 500 and 0 mg, respectively. Dark-chocolate ingestion not only proved to decrease blood pressure but also to improve glucose metabolism and insulin sensitivity in the subjects. They therefore proposed that it was polyphenol-rich dark chocolate – not white chocolate (which contains mainly sugar and cocoa butter) – that decreased blood pressure and improved insulin sensitivity.

In another study, Romanczyk and colleagues[16] examined the anti-carcinogenic properties of cocoa extracts using several human cancer-cell lines. Interestingly, the effects were seen only with oligomeric procyanidins and, of these, in particular, with oligomers of 5±12 sub-units, with the most effective being the pentamer. It was suggested that the mechanisms by which procyanidins exert anti-carcinogenic activity include the inhibition of DNA-strand breaks, DNA-protein cross-links and the free radical oxidation of nucleotides due to their antioxidative activity as well as the inhibition of the activities of COX-2 and DNA topoisomerase II. Procyanidins moreover modulate NO production through macrophages, which possess an inducible nitric oxide synthase (iNOS) and thereby affect ribonuclease reductase, the enzyme that converts ribonucleotides into deoxyribonucleotides necessary for DNA synthesis. The inhibition of DNA synthesis may be an important way in which macrophages and other tissues possessing iNOS can inhibit the growth of rapidly dividing tumour cells or infectious bacteria. These findings indicate that cocoa and dark-chocolate consumption may exert an anti-carcinogenic activity in human cells and offer protective action to the vascular endothelium by improving insulin sensitivity, thereby exerting favourable metabolic effects in humans, with further protection against CVD. Since these findings cannot be generalised for all populations, large-scale trials are obviously needed to confirm

these potentially protective actions of dark chocolate or other flavanol-containing foods in populations affected by insulin-resistant conditions, such as essential hypertension and obesity.

Cocoa, chocolate and aphrodisiac properties

Cocoa and chocolate have been reported to exert several effects on human sexuality, acting mainly as an effective aphrodisiac, increasing sexual desire and improving sexual pleasure.[58] They have been claimed to contain a chemical substance known as phenylethylamine, which has been reported to stimulate the hypothalamus, inducing pleasurable sensations as well as affecting the levels of two neurotransmitters – 5-hydroxytrytamine (serotonin) and endorphins in the brain – hence enhancing mood lifting and sexual drive.[11] These chemicals occur naturally and are released by the brain into the nervous system during situations of happiness and feelings of love, passion and/or lust. This causes a rapid mood change, a rise in blood pressure, an increase in heart rate and an inducement of those feelings of well-being bordering on euphoria that are usually associated with being in love.

In other studies, the cocoa in chocolate has been reported to contain several potentially psychoactive chemicals, such as the sympathomimetic biogenic amines (tyramine and phenylethylamine) and the methylxanthines (theobromine and caffeine).[59,61] Spampinato[62], for example, notes that each 100 g of chocolate contains 660 mg of phenylethylamine ($C_6H_5(CH_2)_2NH_2$), a stimulant similar to the body's own dopamine and adrenaline. Phenylethylamine has been noted to raise blood pressure and heart rate, heightening sensations and blood-glucose levels.[63] Since eating chocolate gives an instant energy boost and an increase in stamina, it is no wonder that the effects of eating chocolate have given chocolate a reputation as an aphrodisiac. Both compounds can also be mildly addictive, which explains the drive of chocoholics. Women are more susceptible to the effects of phenylethylamine and serotonin than men,[58] which explains why more women tend to be chocoholics than men.

Chocolate has also been shown to contain unsaturated N-acylethanolamines, which may activate cannabinoid receptors or increase endocannabinoid levels and result in heightened sensitivity and euphoria.[12] Researchers believe that chocolate contains pharmacologically active substances that have the same effect on the brain as marijuana and that these chemicals may be responsible for certain drug-induced psychoses that are associated with chocolate craving.[10,63] Marijuana's active ingredient leading a person to feel "high" is tetrahydrocannabinol, however, a different chemical neurotransmitter produced naturally in the brain called anandamide has been isolated from chocolate.[12] Because the amount of anandamide found in chocolate is so minuscule, this is not the reason for chocolate giving a person a "high"; rather, it is the compounds such as unsaturated N-acylethanolamines in chocolate that have been associated with the good and "high" feeling that chocolate consumption provides. Anandamide is nevertheless broken down rapidly into two inactive sections after production by the enzyme hydrolase, which is found in our bodies.[12] Other chemicals are present in chocolate, however, which may inhibit this natural breakdown and thus make people feel good for longer when they eat chocolate.

Although chocolate contains chemicals that are associated with feelings of happiness, love, passion, lust, endurance, stamina and mood lifting, scientists continue to debate whether it should be classified as an aphrodisiac. It would be very challenging to say that there is firm proof that chocolate is indeed an aphrodisiac. Chocolate does, however, contain substances that increase energy, stamina, mood lifting and feelings of well-being. The reality is that a gift of chocolate is a familiar courtship ritual that makes people feel good and that induces feelings of being in love.

In conclusion, cocoa and chocolate flavonoids are compounds that are vital to human health This is evidenced by their influence on a number of findings related to their biochemical and physiological functions in the body, with identified potent antioxidant effects under in vitro conditions and *in vivo* after consumption. These antioxidant properties have been related to increases in plasma epicatechin concentrations, to endothelial-dependent vascular relaxation as promoted by cocoa flavonoids due in part to the increased bioavailability of NO and prostacyclin, and to the anti-atherosclerotic properties of NO combined with a favourable shift toward vasodilation, which confers a vasculo-protective effect. The lowering of blood pressure has also been found after short-term dark-chocolate intervention in the presence of mild isolated systolic hypertension. Other known effects from cocoa flavonoids include their suppressive effect on platelet reactivity and platelet-related primary haemostasis, the modulation of immune function, and inflammation as potential cardioprotective effects. Finally, some aphrodisiac effects, mood lifting and heightened sensitivity have also been reported to be due to phenylethylamine and N-acylethanolamine compounds in cocoa and chocolate. As consumers become more aware of the potential aphrodisiac effects and health benefits associated with cocoa and chocolate consumption, they will require more information on whether the intake of these functional compounds and/or their sources is related to measurable effects on human sexual lives, health and/or the development of disease. They will also require relevant information on specific sources and products commonly available in the marketplace as a guide to their selection of foods. The consumption of cocoa and chocolate flavonoids therefore still presents an exciting area of further nutritional, clinical and epidemiological research, with significant implications for sexual health and cardiovascular protection in humans.

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