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Oh How Sweet It Is: The Heart's Love Affair With Chocolate

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Author

Movassaghi, Mehran

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Introduction

With nearly 35 million chocolate hearts exchanging hands this past Valentine's Day, for many chocolate is considered the quintessential romantic gift. But chocolate could be good for the heart in ways other than just by improving romance. For most Americans eating chocolate comes with a sense of guilt. We don't associate it with a healthy lifestyle, unless it coats a Slim-Fast bar or flavors a protein shake. We have been warned by doctors and dentists to avoid overindulgence as it has been linked to numerous medical problems including tooth decay and acne (1). Its high fat content and loads of sugar are other pitfalls which our USDA food pyramid reminds us to "use sparingly." New research, however, is providing a new image for our old friend the chocolate. Soon M&M's and Kit Kat bars may become an important part of maintaining a healthy heart. Chocolate has been shown to have abundant antioxidant activity (3) and to inhibit platelet activation and function¹⁰, both of which contribute to its cardio-protective role. Furthermore, the fat content in chocolate has been shown to increase high-density-lipoproteins (HDL) or the "good cholesterol" as most commoners refer to. Lastly, the fat found in chocolate is mainly stearic triglycerides that are less well absorbed than other fats, and are excreted in the feces (2).

Antioxidant Activity

Chocolate is derived from the cocoa bean. The cocoa bean has been found to be a significant source of natural antioxidants termed flavonoids. These are the same antioxidants that have been isolated in tea, red wine, tomatoes and other foods thought to reduce the risk of cardiovascular disease. The specific antioxidants found in chocolate are most similar to structure to those of grapes and tea; catechins and epicatechins (3). If the processing of the cocoa beans preserves their flavonoids, then the chocolate consumed could provide protection against heart disease. Currently, the Mars Corporation (makers of fine delicacies including Snickers and 3 Musketeers) has developed a method, termed Cocoapro, which preserves these antioxidants (3).

Why should antioxidants be important to health? Cells are continually exposed to reactive oxygen species (ROS) such as hydrogen peroxide (H_2O_2), superoxide anion (O_2^-), hydroxyl radical (OH^\cdot), and hypochlorous acid ($HOCl$), all of which are capable of causing damage. Most ROS are produced through normal cellular metabolic processes, but are prevented from doing harm through antioxidant enzymes within the cells. These enzymes, however, become depleted. Furthermore, other factors including illnesses, aging, air pollution, smoking, or the effects of ultraviolet (UV) radiation can lead to additional ROS which can overwhelm the internal defenses. Thus external sources of antioxidants play a vital role in maintaining healthy cells. They become a second line of defense to scavenge free radicals and prevent damage.

Consumption of foods high in antioxidants, such as fruits and vegetables, has been found to correlate positively with protection against cardiovascular disease, cancer, and cataracts, as well as slowing the effects of aging (2) In the case of heart disease; it is believed that the oxidation of low-density-lipoproteins (LDL's) is an essential step in the

creation of the artery clogging plaque. Phenolic antioxidants have been shown to inhibit the oxidation of low-density lipoprotein (LDL) cholesterol-the same antioxidants found in chocolate (7)

To determine whether chocolate products were rich in phenolic antioxidants, researchers at the University of California-Davis took cocoa powder and baking chocolate from the kitchen and a milk chocolate candy bar from a vending machine and analyzed them using a standard test for phenols in wine (4). They also tested cocoa extract for its antioxidant activity by determining its ability to inhibit oxidation of LDL cholesterol purified from human blood. They found in the three forms of chocolate, cocoa had the highest levels of phenols, followed by baking chocolate and then milk chocolate. A standard 1.5-oz milk chocolate bar had approximately the same quantity of phenols as a 5-oz glass of red wine. The cocoa powder extract was the most potent antioxidant for LDL oxidation. More recently, Joe Vinson at the University of Scranton (PA) (5), has found even higher levels of antioxidants in chocolate. His studies have shown that on a weight basis, "the concentration of polyphenols in milk chocolate is higher than in red wines and black or green teas. It is 20 times higher than in tomatoes, 2 times higher than in garlic, and over 3 times higher than in grapes. M&M/Mars Corporation, working in collaboration with researchers at the University of California-Davis, developed a method for separating and identifying procyanidins, a diverse subgroup of polyphenols that have been primarily linked to the antioxidant found in chocolate. These researchers have found that different fractions of procyanidin oligomers (e.g., dimers, trimers, tetramers) have different antioxidant potentials and, therefore, probably different biological potentials (6). A group of German scientists have rated chocolate's tetramers as top performers among a group of antioxidants in decreasing free-radical oxidation that can damage blood vessel walls (3) Further support for chocolate's antioxidant activity has come from Etheron et. al. (7) who evaluated the effects of cocoa powder and dark chocolate on LDL oxidative susceptibility and serum total antioxidant activity. Using LDL oxidation lag time and oxygen radical absorbance capacity, the cocoa powder/dark chocolate group showed an 8% delay in LDL lag time and an increase in oxygen absorbance capacity. The lag phase of LDL oxidation corresponds to the time required for the endogenous antioxidant to be consumed. The length of lag time, therefore, serves as an index of the quantity and quality of the antioxidants in the LDL particles (8). Similar results were obtained in a similar study by Kondo et al.(9) In the Etheron study, HDL or "good cholesterol" levels were also increased in the cocoa powder/ dark chocolate group, contributing to chocolate's cardio-protective role.

Inhibition of Platelet Activation and Function

Blood platelets play an active role in coronary artery disease, as they are found at sites of atherosclerotic plaques. They secrete specific factors including platelet-derived factor, transforming growth factor β , and epidermal growth factor, which lead to smooth muscle proliferation and progression of the lesions. With platelet inhibition, one can prevent and slow down the progression of the disease. In a recent paper published in the American Journal of Clinical Nutrition, researchers have demonstrated that chocolate's cardio-protective properties reach farther than antioxidant activity alone, they have shown that

cocoa rich drinks can inhibit platelet activity and function. Dr. Carl Keen (10) and his team gave water, procyanidin-rich cocoa, or alcohol-free red wine to a group of 10 men and 10 women. After 2 and 6 hours, blood samples were obtained. While clotting time was delayed in both the cocoa and red wine groups, only in the cocoa group the platelets did not fragment. Platelet fragmentation is a sign of increased adhesion, which contributes to blood clot formation. In a similar study, done by Drs. Rein and Keen (11), cocoa was compared to a caffeinated drink. In this study, platelet activation was measured through expression of activation-dependent platelet antigens and platelet microparticle formation. In both variables, the cocoa consuming group was shown to have decreased platelet activity. Platelet function was measured using collagen-epinephrine induced closure time. In the cocoa group, the closure time was prolonged indicating delayed-platelet related primary homeostasis.

Stearic Fats

While chocolate may be a good source of antioxidants, and even prevent platelet function, it is still high in fat. In fact, 30% of chocolate is fat, mainly from cocoa butter. Cocoa butter is 60% saturated fat (35% stearic and 25% palmitic) and about 40% unsaturated fat (mainly oleic acid). And since it has been proven that saturated fats are associated with cardiovascular disease by increasing total and LDL cholesterol levels (12,13), how can chocolate be good for the heart? To answer this question, scientists have investigated the specific types of fatty acids found in chocolate. Specifically, the stearic acids found in chocolate have been shown to be benign in raising serum cholesterol levels (14). It has been shown that stearic acids are converted to oleic acids in the liver, which are unsaturated, and thus do not contribute to hypercholesterolemia (15). It should be noted, however, that foods high in fat content should be used sparingly, since even stearic acid has been linked to heart disease in ways other than raising cholesterol levels (16).

Conclusion

So then what is the consensus? How can all of this be true? How can a food high in fat, high in sugar, and loaded with calories, be good for you? Furthermore, most of these studies mentioned are funded by the chocolate industry. How can they be trusted? To answer these questions, we must look at the facts and make our own judgments. When the cocoa bean is processed, it is roasted and grinded into cocoa bran and then liquefied into "chocolate liquor". From their cocoa powder and cocoa butter are made. Most candy bars are a combination of the two. It is the cocoa powder that contains the beneficial procyanidins. Dark chocolate contains twice as much cocoa powder as milk chocolate, and white chocolate contains none. Thus, dark chocolate can provide a healthier alternative for chocolate lovers. As for how much chocolate is enough, American's on average consume about 12 pounds of chocolate a year, mostly in the form of candy bars, a form high in sugar and fat content. While the antioxidants it contains are likely to be beneficial for the heart, more in vivo research needs to be done to confirm this. It is true that chocolate has been shown to be rich in antioxidants, decrease platelet activity and increase HDL cholesterol levels, but as mentioned earlier, the research performed has been primarily been funded by the chocolate industry and studies have been small and

usually short. Until further results are obtained, we shouldn't feel guilty the next time we indulge in a Godiva truffle, but we should still limit ourselves. As more government funded research is completed in the near future, however, prescription strength chocolate may become available.

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