A Happy, Healthy Heart: How Chocolate Can Help

by Cord Udall

Imagine asking a hundred people on the street which disease is today's No. 1 killer—what do you think they would answer? "Cancer" would be the most likely result. To the surprise of most people, it's not cancer that kills more Americans than any other disease. The correct answer is cardiovascular disease (CVD)—commonly known as heart disease—and it's not only tops among men, it's also No. 1 among women.

Heart disease accounts for one in every three deaths of Americans annually. And while we hear plenty about new advances in surgery and medications to treat problems of the heart, far too little emphasis is placed on preventing and controlling heart disease through diet and other lifestyle measures.

Over the last couple decades, we've been flooded with information counseling us to avoid cholesterol and certain kinds of fats in our diets. But new research is emerging, helping paint a clearer picture of the factors that contribute to the various forms of today's top fatal diseases.

While science and medicine continue their push for improved drugs and other therapies to treat heart disease, natural supplements can aid in preventing and reversing cardiovascular problems. Surprisingly, one of these is dark chocolate, which is becoming increasingly popular as a supplement in the United States and elsewhere. It's now quite clear that chocolate contains a variety of antioxidants and other nutrients that may fight the effects of cardiovascular disease.

The Prostacyclin Effect

There's another reason to be excited about chocolate's heart-healthy properties. It appears that cocoa may positively affect the production and behavior of prostacyclins, according to Dr. Carl Keen, from the University of California-Davis, who has thoroughly studied the bioactivity of chocolate. Produced in the body, prostacyclins inhibit platelet clotting, reduce the risk of thrombosis and blood vessel constriction, and prevent the oxidation of LDL (the "bad" cholesterol) and its entry into the blood vessel walls, where it can result in inflammation. Prostacyclins also lower the activity of cytokines, agents that contribute to unwanted chronic inflammation. Additionally, prostacyclins activate the production of nitric oxide, allowing blood vessels to expand and become more flexible. Prostacyclins also appear to inhibit the activity of lipoxygenase, an enzyme that plays a pivotal role in the inflammation process. Stopping this inflammatory response reduces blood vessel damage.

Heart Disease: The Beginning

Why does heart disease occur? It's a good question, and typically requires a fairly complex answer. Heart disease doesn't just happen overnight. It usually takes years to develop, and is largely a result of lifestyle habits. We all start out with a very clean heart and blood vessels, which bring nutrients to the heart muscles. But, over time, several factors begin to affect our cardiovascular system and increase our risk of developing symptoms of CVD and stroke. These factors include:

- Diet
- Gender
- Inactivity
- Obesity
- Alcohol or tobacco use
- High cholesterol levels
- Low blood pressure
- Diabetes

Inflammation: Fueling the Fire of Cardiovascular Disease

In addition, the science and health worlds are recognizing the critical role that inflammation—especially chronic inflammation—plays in the onset of CVD.

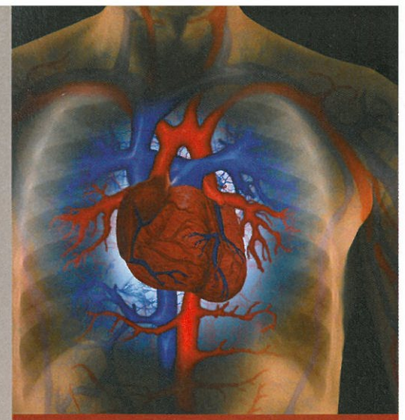
Generally, inflammation is the body's response to injury, which may come in various forms. Bacterial or viral infection, environmental toxins, a high-fat diet, smoking and alcohol are some of the primary causes. The inflammatory process causes a sequence of actions in the heart and vascular system, namely the buildup of plaque, which if allowed to progress will lead to problems ranging from angina and high blood pressure to stroke and heart attack.

Often, inflammation is at the core of a cycle leading to cardiovascular disease. It usually begins because of a combination of unhealthy diet, lack of exercise and other factors. Imagine the unhealthy fats, high blood-sugar levels and chemicals common to the American diet coursing through a person's veins. They irritate the blood vessel walls, leading to a mild state of inflammation, calling the body's attention to an "injury."

This low-grade inflammation makes the vessels susceptible to particles of bad cholesterol, or LDL cholesterol. The LDL particles are ingested by macrophages, whose role is to eliminate pathogens, toxins and other dangerous cells. But, if the exposure to these particles is lengthy, the macrophages begin to swell and eventually turn into fat-laden "foam cells" that enmesh themselves in the blood vessel walls.

To eliminate these foam cells, the body sends helper cells, or T cells. The only problem with this is that T cells also contribute to more inflammation (normally a necessary thing.) In this case, however, inflammation is the last thing the blood vessel needs, and the result is a continuous cycle of unhealthy fats attaching to the blood vessel wall.

At first, the damage is minor and takes the form of fatty streaks or plaques. But, as the body tries to cope with the disease, it begins to place a fibrous covering over the plaque, which results in hardening of the arteries. This can cause numerous problems. The plaques can get so big they stop blood flow.



Nitric Oxide (NO): Necessary for a Healthy Heart

Numerous studies tell us that damage to the lining, or endothelium, of the blood vessel walls is a major factor in the progression of CVD and eventually heart attack, stroke and other coronary events. We also know that a healthy endothelium depends on nitric oxide (NO). Nitric oxide has risen to the status of chemical superstar in recent years, as American researchers won the Nobel Prize in 1998 for their work involving NO. Other research on cocoa and its components suggests that chocolate-based foods may positively affect the body's production and use of NO. Consequently, we know that nitric oxide is crucial to the health of the endothelium and cardiovascular system in general, because it does the following:

- It allows blood vessels to dilate, or become more relaxed. This means that the blood vessels can expand when necessary, reducing the risk of a number of health conditions.
- It reduces the clotting action of red blood platelets, which decreases risk of stroke and related conditions.
- It inhibits the production of smooth-muscle cells in the vascular system and smooth-muscle contractions.
- It stops LDL-C oxidation.
- It stops the expression or action of cell-adhesion molecules.
- It slows the recruitment of the pro-inflammatory leukocytes to a particular area.
- It reduces oxidative stress in the vascular system by inactivating superoxide anion, a potent free radical.

In addition, the plaques rupture, causing blood clots, which can cause a heart attack or stroke. Or, the hardening of the arteries leads to high blood pressure, which contributes directly to an enlarged heart, damage to organs and tissues, and congestive heart failure. With congestive heart failure, fluid builds in the lungs, liver and lower legs, the heart bogs down and cannot pump efficiently, which ultimately leads to death. Hardening of the blood vessels also contributes to dementia, kidney failure, blindness and skin ulcers.

Studies now confirm the notion that inflammation can play an important role in triggering a heart attack. This may explain why those with normal cholesterol levels may still have a heart attack. "The implications of this are enormous," says Dr. Paul Ridker of Boston's Brigham and Women's Hospital in a 2002 Associated Press article. "It means we have an entire other way of treating, targeting and preventing heart disease that was essentially missed because of our focus solely on cholesterol."

The shift in how the medical world views heart disease could be dramatic. Dr. Eric Topol, Department Chairman of the Cleveland Clinic Heart Center, recently stated that the emerging data about inflammation will, "change everything we do in heart disease." He adds that, in the past, the focus was on the danger of high cholesterol. Now doctors will talk to their patients about the risks of high C-reactive protein levels.

The Threat of Free Radicals

It doesn't matter how healthy we are or what kind of environment we live in, our bodies are exposed daily to a cellular process called oxidation. The same oxygen we breathe also puts our cells at continuous risk because of oxidation, the same process that causes metal to rust, fats to go rancid and fruit to turn brown.

In the human body, oxidation also causes damage to healthy human tissues on a cellular level. Over time, this damage results in what we generally call aging and it can put our health at risk. Free radicals, or oxidants, are a natural by-product of cellular metabolism, a beneficial bodily process needed, among other things, to fight infections, convert glucose into energy and build muscle mass.

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For many experts, the unearthing of chronic inflammation's ill effects on the cardiovascular system means a top-to-bottom rethinking of the origins and prevention of heart trouble. It's a revolutionary departure from viewing the world's top killer as largely a plumbing problem blamed on cholesterol-clogged arteries, the standard theory throughout modern cardiology.

Consequently, a growing number of cardiologists are calling for routine screening for chronic inflammation by testing for C-reactive protein—a substance in the blood that is a marker for inflammation. An elevated level of C-reactive protein raises red flags for cardiovascular health.

These natural by-products—free radicals—are unstable and highly reactive in the body. In simple terms, free radicals are unstable molecules because they lack an electron and are constantly scavenging healthy cells for a replacement electron. Experts estimate that every cell experiences 10,000 free radical attacks each hour of every day.

If that sounds serious, it is. Unless these scavengers are neutralized, they may succeed in stealing electrons from healthy human cells, leaving those cells damaged and unstable—creating a chain reaction of dangerous cell mutations. DNA damaged by free radicals can cause cells to replicate incorrectly (or not at all), interfering with proper cell function and often resulting in cell death. Over time, these mutations cause aging and may lead to cancer and other forms of chronic disease. It has been estimated that more than 200 diseases are associated with free-radical damage and oxidative stress.

We can receive protection from the oxidative and carcinogenic effects of free radicals in the form of antioxidants—compounds found in various natural food sources, typically plants. Antioxidants work on a cellular level to deactivate free radicals in the body, neutralizing their effects and preventing cell damage, reducing the risk for disease and slowing the aging process.

Most of us understand that cancer is one disease associated with abnormal cell duplication, but oxidative damage has been linked to more than 60 diseases, including cancer. These are just a few of the primary conditions linked to free-radical damage:

- Diabetes
- Heart disease
- Arthritis
- Cancer
- Cataracts
- Alzheimer's/dementia
- Multiple sclerosis
- Inflammatory bowel disease
- Lung disease
- Autoimmune dysfunction

> The tests showed the chocolate measured significantly higher than green tea and red wine in antioxidant content.

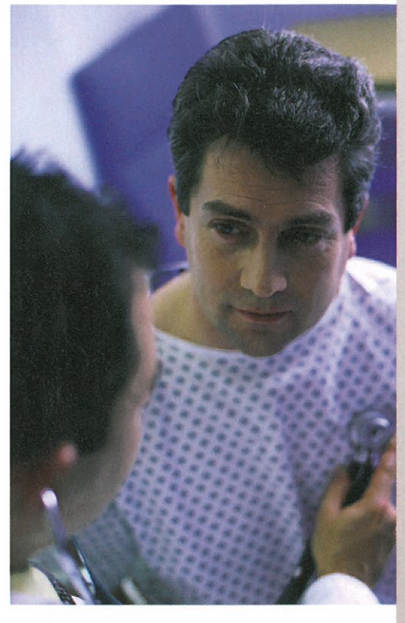
Chocolate's Heart-Healthy Compounds

Among the cocoa bean's most important phytonutrients are several classes of polyphenols, largely recognized as some of the most powerful antioxidant and anti-inflammatory compounds known today. Polyphenols are found in a variety of fruits and vegetables ranging from onions to apples, green tea, grapes and the cocoa bean. Polyphenols comprise multiple categories, including phenolic acids, simple phenols, phenylpropanoids, quinines, stilbenes, xanthones—and the largest group—flavonoids (also called bioflavonoids). The following are just some of the known heart-healthy agents in cocoa:

- Flavones
- Flavonols
- Flavanone
- Flavanol (flavan-3-ols)
- Isoflavones
- Anthocyanidins
- Prostacyclins
- Gallic acid
- Catechins
- Epicatechins

Flavonoids are some of the compounds that provide plants, vegetables and fruits with their color—with reds, purples and blues the most prevalent. In plants, flavonoids help provide protection from disease and ultraviolet rays. Flavonoids affect the taste, color, bitterness and other attributes of plants. Substantial evidence suggests that the darker the skin of a fruit, the more antioxidants it contains. With chocolate, the same holds true—the more bitter the cocoa, the more antioxidant compounds—like flavonoids—it contains.

In short, flavonoids are an impressive group. Abundant research demonstrates they possess anti-inflammatory, antioxidant, antibacterial, anticancer, and antiviral properties, as well as the ability to act like hormones (without the damaging side effects), protect and repair the liver, normalize blood-sugar levels, relax and dilate the blood vessels, modify blood platelet



clotting, maintain mental function, lower the risk of different forms of dementia, fight cancer, prevent cavities and other forms of oral disease, and relieve allergy symptoms, among other possible benefits.

For many years, scientists have believed that green tea and red wine (or grape juice) were the food sources most rich in catechins and epicatechins, which are generating much excitement because of their apparent ability to fight cancer, regulate cholesterol and blood pressure levels, and reduce blood clotting and the risk of heart attack and stroke.

But research is proving otherwise. A recent study from researchers at Cornell University showed that dark chocolate scored higher than both green tea and red wine. "If I had made a prediction before conducting the tests, I would have picked green tea as having the most antioxidant activity," says Chang Lee, Ph.D., who led the research efforts. "When we compared one serving of each beverage, the cocoa turned out to be the highest in antioxidant activity, and that was surprising to me."

Even Chocolate Snacks Offer Protection

A 2004 study has revealed that a combination of flavonoids from cocoa and sterols from soy can significantly reduce cholesterol levels. The study involved the consumption of a cocoa-based snack bar with added sterols, and demonstrated how even snacks can contribute to a healthy heart.

Various studies have already demonstrated cocoa contains naturally occurring, heart-healthy compounds. And the inclusion of soy sterols in the diet has also been recommended by the American Heart Association as a lifestyle change to significantly lower the risk of heart disease. This study sought to determine if the consumption of both cocoa polyphenols and sterols in combination would lower cholesterol levels and the risk of heart disease.

In the study, one group of 35 participants received a placebo snack bar (the control group) twice a day while the other group of 35 participants ate the cocoa and sterol-containing bar twice daily (the treatment group). Study participants had their cholesterol levels checked twice at the beginning of the study, again at the midpoint of the study and twice at the end of the six-week study period.

At the end of the study, total and LDL cholesterol and the ratio of total-to-HDL cholesterol decreased significantly by 4.7 percent, 6 percent and 7.4 percent, respectively, in those who consumed the sterol and cocoa-based snack bars. In the control group, plasma lipids did not change.

Plant sterols are clinically proven to lower cholesterol and may reduce the risk of heart disease. Physicians and cardiologists have recommended sterol-containing foods to patients at higher risk of heart disease. Similar to the antioxidants in tea and red wine, studies suggest cocoa flavanols may have positive effects on heart health by reducing oxidation of LDL cholesterol, promoting healthy blood pressure, making blood vessels more pliable and maintaining healthy blood flow. This study suggests the need of development of more food options that include such heart-healthy ingredients as plant sterols and cocoa flavanols.

Photo: Mark Perlstein

The tests showed the chocolate-based drink measured significantly higher than green tea and red wine in catechin and gallic acid content, both known for their antioxidant capabilities. Epidemiological studies focusing on green tea consumption (and thereby catechin consumption) aren't yet conclusive, but early results suggest those who drink green tea live longer than those who don't.

Of course, there are many other classes of polyphenols and phytonutrients, some of which are found in chocolate. While there's still much research to be done, that which is already completed paints a very positive and promising picture of the health benefits of these amazing compounds.

The Research Behind Chocolate

Dozens of studies suggest the ability of dark chocolate to protect the heart in a variety of ways, including fighting the previously explained inflammation and oxidative damage, improving blood platelet function, decreasing the clotting of blood, and allowing blood vessels to relax and become more pliable, which lowers blood pressure. In addition to those studies discussed elsewhere in this article, the following are highlights of other important findings.

Study No. 1

To further assess the various claims regarding the ability of chocolate to fight CVD, a team of scientists from the Harvard School of Public Health reviewed 136 studies of the relationship of chocolate and cocoa to cardiovascular health. The review included all types of research from lab tests to human studies. The research team concluded that chocolate is a major source of flavonoids (epicatechins, catechins and procyanidins) and found that the principal fat in chocolate—stearic acid—did not have adverse effects on blood vessels, cholesterol levels or overall CV health, because it's metabolized differently than other saturated fats.

The review also confirmed the findings of many studies that suggested regular chocolate intake can potentially protect the heart and vascular system in a variety of ways. These include lower blood pressure, decreased inflammation in blood vessels, decreased blood clotting, increased levels of high-density lipids (HDL—the good cholesterol) and decreased oxidation of low-density lipids (LDL), improved endothelial function (increased nitric oxide production), inhibition of leukotriene activity (which causes the constriction of blood vessels and contributes to chronic inflammation), and increased activity of prostacyclins, which help blood vessels relax and reduce blood platelets from forming clots. Pretty impressive stuff.

Study No. 2

A February 2006 study published in the *Archives of Internal Medicine* presented new data on cocoa intake and heart disease from older men. A Dutch research team followed 470 men aged 65 to 84 for more than 15 years. Food histories were taken and subjects divided into three groups by daily cocoa intake—none, low or high. The high cocoa intake was equivalent to eating about 10 grams of a standard dark chocolate daily.

The results were very promising, with the high-cocoa group demonstrating slightly lower blood pressure and a 45 to 50 percent lower rate of death from cardiovascular disease. Because the difference in blood pressure was relatively small, the researchers concluded that the decrease in risk of CVD must be explained by other possible benefits of chocolate consumption, such as improvements in the function of blood vessels, lower blood-glucose levels, decreased platelet clotting, improved cholesterol levels, protection of blood lipids against oxidation, and reduced activity of inflammatory components such as cytokines.

"The key message is that our study suggests that using low amounts of cocoa foods on a daily basis, equal to about 10 grams of dark chocolate, may lower blood pressure and CVD [cardiovascular] death," says lead researcher Brian Buijsse, M.Sc.

The study's authors concluded this long-term review supports the findings of various short-term studies indicating chocolate intake can improve cardiovascular health and lower the risk of cardiovascular disease.

Study No. 3

Research completed by a team from the University of California-Davis and Tufts University, and published in a 2005 issue of *The American Journal of Clinical Nutrition*, found the proanthocyanin and flavanol content of cocoa demonstrated significant antioxidant properties and the ability to protect the heart and vascular system. "These nutrients have been shown to affect numerous intracellular signaling cascades, and to influence the cardiovascular system by enhancing vascular function and decreasing platelet activity," states lead researcher Dr. Carl Keen.

The researchers discovered the epicatechin content of dark chocolate is likely responsible for the improved relaxation of blood vessels by enhancing the function of the blood vessels' endothelial lining. It's also important to note that the patients' blood levels of lipids did not increase during the trial. Additional review of research, which was compiled by some of the same researchers, suggests that flavonoids from chocolate have an anti-inflammatory effect by controlling the activation of several pro-inflammatory agents in the body.

Study No. 4

A 2006 study completed by a team of researchers from the University of California-Davis and the University of Dusseldorf in Germany ascertained the compound epicatechin found in cocoa is directly linked to improved circulation and other hallmarks of cardiovascular function. State the researchers, "The results of the study provide direct proof that epicatechin is, at least in part, responsible for the beneficial vascular effects observed after the consumption of certain flavanol-rich cocoa [foods]." The researchers also explained that the relaxation response observed in the blood vessels of the subjects was mediated by nitric oxide (NO), a key signal released by the inner lining of blood vessels (the endothelium).

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Crucial to the study were volunteers from a Panamanian group of Indians called the Kuna. High blood pressure and other signs of cardiovascular disease are rare among the island-dwelling Kuna, who are also known to consume large amounts of chocolate (usually in the form of a hot beverage, about three to four cups a day). Previous studies have shown that Kuna who have migrated to urban environments, and consequently consume less cocoa, do not enjoy the same level of cardiovascular health. Upon returning to a regular intake of the cocoa beverage, the researchers found that the risk factors for CVD and related problems were reduced significantly.

Study No. 5

Famed sisters and colleagues Mary and Marguerite Engler recently completed a study that shed light on exactly how chocolate and its key ingredients improve the health of the endothelial lining of blood vessels. In the study, 21 subjects were given either high-flavonoid, dark-chocolate bars or low-flavonoid chocolate bars every day. After two weeks, the subjects were tested for changes in their endothelial function, blood pressure, blood-lipid profile and blood-epicatechin concentrations.

The results were impressive, indicating the endothelial function of those eating the high-flavonoid chocolate was significantly higher than those eating the low-flavonoid chocolate. In addition, the blood-epicatechin concentrations of the high-flavonoid group were also significantly higher than the low-flavonoid group. These results led the researchers to state that consumption of flavonoid-rich dark chocolate improves the function and health of the blood vessel wall (endothelium), which plays a pivotal role in the overall health of the heart and cardiovascular system, and may provide other cardioprotective benefits because of the increased catechin concentrations.

In addition, a review conducted by the Engler sisters supported these findings. In the review, they suggest that possible benefits of consumption of cocoa flavonoids include protecting the entire cardiovascular system, optimizing nitric oxide production and increased antioxidant activity. They suggest that regular consumption of flavonoids can prevent the oxidative stress brought about by the various common risk factors. **BIH**