

Trans fatty acids are potentially harmful to human health. This is due to their structural similarity to saturated fats. There is substantial evidence to suggest that TFA elevate the concentration of bad (low-density lipoprotein) cholesterol in the blood while reducing the level of good (high-density lipoprotein) cholesterol (Coulter 2002, Mauger et al 2003, Stachowska et al 2004, Tavella et al 2000). This is an important risk factor in cardiovascular disease. Moreover, TFA are positively correlated with the risk of atherosclerosis and ischemic heart disease (Stachowska et al 2004).

In Australia it is believed that TFA are extensively removed from manufactured spreads. As a result, the body responsible for food product labeling, Food Standards Australia New Zealand (FSANZ) has not mandated any legislation to label the TFA content in manufactured foodstuffs (FSANZ 2002). If a nutrition claim is made in relation to cholesterol, saturated, unsaturated or TFA then the label must identify the TFA content. In comparison, Denmark currently bans the sale of food products where there is greater than 2% TFA in the total fat content. Earlier this year, Choice magazine tested 55 food products to determine the TFA content (2005). Interestingly, they found a number of food products with a TFA content that would be banned in Denmark. Yet, because there is currently no mandatory law in Australia, they are permitted here. Furthermore, imported food products that contain partially hydrogenated oils may also contain significant levels of TFA. As a result consumers may unintentionally be consuming some TFA in such products.

In considering the totality of the evidence it has been accepted by health authorities in many countries that TFA are harmful to human health. If a significant portion of TFA is removed from manufactured products then there is no cause for concern. However, if manufacturers are not required by law to label their products there is no guarantee to the consumer that the removal of TFA does routinely occur. (A suggestion to

consumers is to check the product label of margarines to see if it says the margarine is TFA free.) As such the exclusion of TFA from product labels makes it difficult for consumers to avoid them. Therefore, it should be clear that mandatory labeling is something FSANZ should consider in order to enable consumers to make informed choices and to protect the health of all Australians.

This article has been edited for Nutrition Australia by Professor Andrew Sinclair, Professor of Human Nutrition, School of Exercise and Nutrition Science, Deakin University, Burwood Campus

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A critical look at the effects of cocoa on human health

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What is Cocoa and Chocolate?

The beans of the Theobroma cacao plant are processed and used to produce 'cacao liquor', sometimes simply referred to as cocoa. Cocoa can either be added to sugar and other ingredients such as milk solids to create 'chocolate' (either 'dark' or 'milk') or have its fatty portion (cocoa butter) removed to form 'cocoa powder' - the substance often used as 'chocolate flavouring' when added as an ingredient to other foods.

In Australia there are no specific food regulations to define the different types of chocolate; however, the percentage of key or characterising ingredients must be listed on the ingredients list. Generally chocolate with a higher proportion of cocoa is referred to as dark chocolate and will have the amount of cocoa it contains in the ingredients list. Milk chocolate contains milk solids and smaller amounts of cocoa and the percentage of milk and cocoa will be listed. White chocolate may not have any cocoa at all so it has been debated nationally and internationally whether it should be called chocolate at

all. There are many varieties of mixed chocolates and the foods that can be made from chocolate are limited only by imagination.

Is chocolate a health food?

Typically, we have long thought of chocolate as confectionery and might not consider confectionery a healthy food. Published studies are accumulating that suggest cocoa and dark chocolate may decrease the risk factors of some lifestyle related diseases including diabetes and cardiovascular disease. The proposed mechanism, or the reason for these potentially beneficial effects on our health, is thought to be due to its high concentration of polyphenolic compounds; specifically a class of flavonoids called catechins and their oligomeric form referred to as procyanadins.¹ Indeed, other flavonoid rich foods have gained attention as being potentially heart-healthy (and to some extent, even cancer-preventative) such as tea (especially green tea) and wine (especially red wine) which funnily enough were also once thought of as being unhealthy.

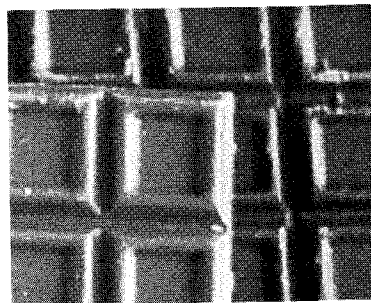
The evidence that cocoa and dark chocolate may exert certain benefits on our health have been viewed with excitement by avid chocolate lovers, and have even lead to recommendations by prominent Australian dietitians that chocolate may contribute towards a healthy diet.³ Unfortunately the evidence to date is contradictory and preliminary therefore health-care professionals should be cautious about making such recommendations.

Cholesterol and Cardiovascular Disease

The original concern regarding chocolate and cardiovascular disease was related to its high concentration of fat, a significant percentage of which is 'saturated'. Interestingly the most abundant 'saturated' fatty acid in cocoa is the 18 carbon stearic acid which, despite being 'saturated' does not cause serum cholesterol levels to rise after ingestion.³ Some evidence from population studies have found an increased risk of heart disease associated with higher intakes of stearic acid,⁴ although with the exception of cocoa products, most foods rich in stearic acid are also high in the other saturated fats, which do elevate cholesterol levels.

Some recent investigations have found that consumption of dark chocolate has no harmful effect on serum cholesterol levels; however reports that dark chocolate can actually improve cholesterol concentrations have been mixed. Of the four recently published studies to examine the effect that dark chocolate consumption (approx. 75-100g/ daily) has on cholesterol levels in humans, two found no effect on LDL 'bad' cholesterol^{5,6} whilst the other two reported moderate improvements;^{7,8} one of these also found an improvement in HDL 'good' cholesterol as well.⁶

Regardless of the effect that it may have on cholesterol concentrations, cocoa products have been shown to decrease susceptibility of LDL cholesterol to oxidation in laboratory investigations,⁷⁻¹⁷ as well as most^{6, 18-20} but not all²¹⁻²² human studies. In vitro, the antioxidant activity of cocoa decreased LDL oxidation even more so than green and black tea,²³ which are known to have antioxidant activity far greater than most fruits and vegetables.²⁴ Another way in which cocoa products may exert a cardio-protective action involves its ability to 'thin the blood' by decreasing platelet activation. Human studies have revealed a decrease in platelet activity after being given dark chocolate²⁵, cocoa beverage²⁶ or a cocoa flavonol supplement.²⁷



Hypertension

The original notion that cocoa may possess antihypertensive properties comes from observational studies among the heavy cocoa consuming Khuna Indians in Panama; a population renowned for their lack of high blood pressure²⁸. Although a cause-and-effect relationship has not conclusively been established, several clinical trials have supported the notion that cocoa may exert favourable effects on blood flow and pressure.

Several studies have revealed that consumption of either cocoa beverage^{29,30} or small portions of dark chocolate³¹ can improve flow mediated dilation (a measurement of the ability of the artery to relax and expand to accommodate increased blood flow), but not decrease blood pressure. Other studies found that it required at least 100 grams per day of flavonol rich dark chocolate before any decrease in blood pressure was observed in either hypertensive^{32,7} or normotensive³ subjects. Because it was found that cocoa consumption causes the vascular endothelium to release nitric oxide, (a hormone responsible for dilating the blood vessels) it has so far been presumed that this is the mechanism of action responsible for these observed effects.^{33,34}

As is the case with cardiovascular disease, there is no evidence from population studies to suggest that chronic consumption of cocoa products affect the risk of hypertension. Other than the recently published results of a prospective study which found no association between the incidence of hypertension and chocolate consumption among over 5000 men and women in Spain, this is an issue that lacks epidemiological evidence.³⁵ Moreover, the amount of dark chocolate needed to produce significantly favourable results in blood pressure would inevitably result in weight gain; a factor known to be detrimental in the fight against hypertension.

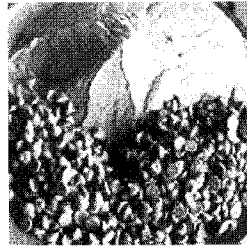
Diabetes

Two recently published studies by Davide Grassi^{5,7} and his co-workers at the University of L'Aquila in Italy, revealed that 100g of flavonoid-rich dark chocolate per day resulted in a decrease in both fasting glucose and insulin levels, as well as a decreased insulin resistance and an increase in insulin sensitivity. Since these results were published, news reports that dark chocolate can fight diabetes have been circulating around the globe. Other than the obvious concern that increased consumption of calorie rich chocolate may lead to weight gain there are several other issues which should be considered before making recommendations for diabetics to start eating dark chocolate.

Professor Jennie Brand-Miller and her colleagues at the University of Sydney conducted a study several years ago which examined the different effects on insulin and glucose levels that foods with added cocoa would have, compared to the ordinary variety (without cocoa)³⁶. They observed no difference in glycaemic response between the two varieties, however the cocoa fortified foods caused a 28% average increase in insulin levels. Whether an increase in insulin levels in the absence of change in glucose concentrations has a beneficial, harmful or neutral effect on diabetic health is thus far unknown.

Grassi and co authors^{5,7} were unsure precisely how the dark chocolate was affecting the insulin levels in their subjects, and suggested that perhaps the effect on nitric oxide metabolism may play a role. From the results published by Brand-Miller and co-authors using cocoa powder, (devoid of cocoa butter) it may be plausible to suggest that either cacao's lipid fraction may play a role, or perhaps even the specific flavonoid compounds present in dark chocolate that are altered during the production of cocoa powder³⁷ may be responsible. Another possible explanation for Grassi's^{5,7} results may be due to the fact that cocoa products are very rich sources of the trace mineral chromium³⁸, which is important for proper insulin function.³⁹

Regardless of the mechanisms involved, given the conflicting results between the Italian studies and the Australian one, and given the fact that these studies examined the effect in non-diabetic subjects, it may be too early to make recommendations to diabetics to consume more cocoa rich foods until further investigations can shed additional light on the matter.



Cancer

Some of the cardioprotective mechanisms that cocoa have been shown to possess, are similar to that of several other flavonoid-rich foods and beverages such as wine and tea.⁴² In more recent years, some of these flavonoid-rich foodstuffs have also been shown to have an anti-carcinogenic action both in vitro and animal models - a phenomenon which has been supported by some but not all epidemiological data.^{41,44}

Preliminary evidence from in vitro studies suggests that cocoa polyphenols induce a non-apoptotic death in both colon⁴⁵ and breast cancer⁴⁶ cell lines. Whilst enzymes involved in polyamine biosynthesis were found to be affected, the precise anti-cancer mechanisms are poorly understood at this stage. Animal studies have also demonstrated that cacao liquor extract may help defend against cancers of the liver⁴⁷ and pancreas⁴⁸, however no such evidence exists in human studies. Evidence from population studies suggest that higher intake of sweet foods such as chocolate, increase the risk of breast cancer^{49,51} colorectal cancer⁵² and gastric cancer.⁵³ Additionally, a case-control study in Africa⁵⁴ found an increase in the risk of bladder cancer among higher consumers of cocoa products, however a cohort study in Italy⁵⁵ found no such correlation. Most of these studies however have not looked specifically at dark chocolate, so given the recent evidence from laboratory investigations to suggest a possible chemoprotective role of flavonoid-rich cocoa products, (such as dark chocolate) any such correlation among humans should be looked at more closely in future population studies.

Discussion and Conclusion

Although it is clear that consumption of dark chocolate may not raise serum cholesterol levels, raise blood pressure or induce LDL oxidation, whether or not it can favorably affect these biomarkers of cardiovascular disease remains to be seen. The studies that have revealed improvements in these markers have used significantly greater doses of dark chocolate than have those with disappointing outcomes. This would mean that theoretically, to obtain any significant cardioprotective effects from flavonoid-rich dark chocolate, you would need to be consuming at least 100 grams daily, which would result in an additional 530 Calories per day.⁵⁶ Without a significant cut back in calories elsewhere, such an increase in dietary energy would inevitably lead to significant weight gain which, given that approximately two thirds of the Australian population are considered overweight or obese,⁵⁷ could result in a disaster for public health.

Consequently, trying to consume large doses of dark chocolate in order to protect ones self against these diseases may be essentially cutting off one's nose to spite one's face, so to speak. Sending a message to the public that 'significant doses of

flavonoid-rich dark chocolate may improve certain biomarkers of cardiovascular disease, only if done so in combination with a low caloric diet and lots of exercise' could easily be interpreted by the public as 'chocolate is healthy'. Is this the message we want to send? At very best, recommendations to consume more dark chocolate may be of use in underweight individuals trying to gain weight without increasing their risk of diseases associated with saturated fat intake. So for now chocolate remains a food that is not included in the Australian Guide to Healthy Eating and the recommendation is to choose these foods only sometimes or in small amounts.

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