

**PRC/3/4/Rev.1**  
21 November 2005

Original: ENGLISH  
Distr: RESTRICTED

**PROMOTION COMMITTEE**

Fifth meeting

London, 8 December 2005 at 3.00 p.m.

**INVENTORY OF THE HEALTH AND NUTRITIONAL ATTRIBUTES OF  
COCOA AND CHOCOLATE**

**Note by the secretariat:**

This revised document has been compiled using information from various sources including publications by the Biscuit Cake Chocolate and Confectionery Association (BCCCA), scientific journals, reports of conferences and seminars, and web based research. A bibliography of books, papers and reports related to health and nutritional attributes of cocoa and chocolate has been attached.

This inventory has, after a revised draft had been prepared by the secretariat, been reviewed by an external consultant, kindly provided by the BCCCA. The consultant has completed the revised inventory.

## INVENTORY OF THE HEALTH AND NUTRITIONAL ATTRIBUTES OF COCOA AND CHOCOLATE

### INTRODUCTION

1. At its second meeting in September 2004, the Promotion Committee considered the need for a campaign to counter the negative claims about chocolate and obesity and to emphasize the positive health and nutritional aspects of cocoa. The Committee deliberated on activities to promote the positive image of cocoa and chocolate products and requested the secretariat to produce an inventory of the positive health and nutritional attributes of cocoa and chocolate. This document presents an overview of the health and nutritional properties of cocoa and cocoa products. To present a balanced picture, the main perceived negative concerns regarding cocoa and chocolate are also reviewed.

2. It is recalled that, in 1998, a project on the Generic Promotion of Cocoa and Chocolate Consumption was completed in Japan. In 1999, the ICCO published a book on “Chocolate and Cocoa: Health and Nutrition” in co-operation with the International Cocoa Research and Education Foundation (ICREF). The book provided an extensive overview of the health and nutritional aspects of cocoa and chocolate consumption. Presently, ICCO is co-operating with the Russian chocolate industry to formulate and implement a project on the generic promotion of cocoa and chocolate consumption in the Russian Federation.

3. This document presents a summary overview of the book on Chocolate and Cocoa: Health and Nutrition. It also highlights the results of some recent scientific studies conducted on the health and nutritional attributes of cocoa and chocolate in relation to the health benefits of new compounds discovered in cocoa. Additional sources of information for this review include publications by the Biscuit Cake Chocolate and Confectionery Association (BCCCA), other publications, scientific journals, reports of conferences and seminars, and web based research. References are indicated in footnotes for more detailed information and acknowledgement.

4. In outlining the health and nutritional properties of cocoa and chocolate, it is important to distinguish between cocoa beans, intermediate products derived from the cocoa bean (cocoa liquor, cocoa powder, cocoa butter) and chocolate, as some properties are either lost or added during the processing of the cocoa bean and in the manufacturing of chocolate. For instance, nutritional attributes of cocoa butter differ from those of cocoa beans, while milk chocolate has properties which are different to cocoa powder.

5. People consume chocolate because they like it. It has a unique taste and texture, melting in the mouth as the melting point of cocoa butter is close to body temperature. Health and nutritional considerations are of a rather recent date. The oldest among them are the perceived negative consequences of chocolate consumption such as acne, migraine and dental caries. More recently, attention has shifted to focus more seriously on both the negative and positive health properties of cocoa and chocolate, particularly in relation to heart disease and obesity. The above mentioned book on “Chocolate and Cocoa: Health and Nutrition” provided a comprehensive overview of the latest thinking in this area at that time. Since then, more research has been conducted and additional health properties of cocoa have been established. The present document presents the familiar positive and negative attributes of cocoa and chocolate consumption and attempts to provide an update of recent research findings.

## **SUMMARY OF THE FOOD VALUE OF COCOA AND CHOCOLATE**

6. Cocoa is a plant-based food that contains carbohydrates, fats, proteins, natural minerals and some vitamins. Like several other plant foods such as tea, red wine, fruits, vegetables and nuts, cocoa contains a group of compounds which exhibit health benefits, although these may be affected by fermentation and processing of the cocoa beans. Dark chocolate and milk chocolate contain different proportions of cocoa liquor and other ingredients such as milk, which affects the amount of nutrients and anti-oxidants in the final product. These differences are important when analysing the health benefits of chocolate. Dark chocolate has the most chocolate liquor and thus the most natural compounds in cocoa beans that give chocolate its bitter taste. Milk chocolate contains less of the compounds occurring in cocoa beans because it is diluted with milk. Carbohydrates are naturally present in cocoa in the form of starch and fibre. However, in milk chocolate, added sugar forms the greater part of carbohydrate in the final product. Carbohydrate contributes to the calorie content of cocoa and chocolate.

8.7. Cocoa contains some protein, but the amount in dark chocolate is small. In milk chocolate the protein content is enhanced by milk protein.

9.8. Cocoa beans and cocoa liquor contain approximately 50% fat. A significant proportion of chocolate, especially dark chocolate, is fat from cocoa butter. The fat in cocoa butter is comprised of two saturated fatty acids, palmitic and stearic acids, a monounsaturated oleic acid. There are also small amounts (less than five per cent) of other fatty acids. Consumption of saturated fats is associated with increased blood cholesterol levels, and thus increased risk of heart disease. However, a number of studies have shown that consumption of cocoa butter and chocolate do not raise blood cholesterol. This is thought to be due to the relative high concentrations of stearic acid, which studies have indicated to have a cholesterol-neutral effect, and oleic acid which is known to have mild cholesterol-reducing effects. Cocoa butter is reported to contribute proportionally more stearic acid than any other naturally occurring fat.

9. The cocoa component in chocolate is rich in a number of essential minerals, including magnesium, copper, potassium and manganese, sodium, calcium, iron, phosphorus and zinc, which perform important roles in the physiology of the human body. Dietary copper is believed to contribute to the prevention of heart disease and chocolate is thought to be one of the largest single contributors of copper to the diet in the United States. Milk chocolate also contains calcium and can make a significant contribution to the overall mineral intake of this mineral.

10. Chocolate is also a source of vitamins. Cocoa contains vitamin E and some of the vitamin B complex (thiamine, riboflavin and niacin). Cocoa butter contains vitamins A and E. Milk provides additional vitamins, in particular riboflavin and vitamin B12.

## HEALTH AND NUTRITIONAL ATTRIBUTES OF COCOA AND CHOCOLATE

### Cocoa is a natural plant food

11. The cocoa tree is a plant, which produces cocoa pods containing cocoa beans used mainly in the manufacture of chocolate and chocolate drinks. Like other plant-based products such as apples, berries, red wine and tea, cocoa beans contain many naturally occurring compounds which exhibit biological activity and these have been the subject of numerous scientific studies. Cocoa was given the botanical name *Theobroma cacao*; theobroma means “food of the gods” and cacao is derived from the Olmec and Mayan languages (kawkaw). The Mayan and Aztec people of South America consumed chocolate as a beverage, prepared from ground cocoa beans mixed with maize, spices and water beaten into a froth. In the 16<sup>th</sup> century, the Spanish introduced it into Europe where it was made into a beverage with sugar called “choclatl”. One of the naturally occurring group of compounds in plant food, which are particularly rich in cocoa, are flavonoids. Previous studies have indicated that flavonoid-rich foods, such as fruits, vegetables, tea and red wine, might offer cardiovascular benefits. The presence of these compounds in cocoa has completely changed the perceived health benefits of the consumption of cocoa and chocolate. More details of the health benefits of these compounds are outlined in the cardiovascular section of this document. Cocoa has a unique natural taste and colour and possesses a delicious aroma used in many food products for extra flavour and colour. The natural properties of cocoa make chocolate pleasurable with a high “feel good factor”. Since ancient times, chocolate has been associated with pleasure, passion and energy.

### Chocolate is a source of body energy

12. Chocolate is a source of energy, containing minerals and vitamins, needed for growth and energy replenishment. Chocolate can provide the much-needed compact, portable and well liked form of carbohydrate to the fuel needs of athletes in training and competition. The energy provided by milk chocolate is approximately 2000kJ or 500kcal per 100g. However, it can certainly be part of a healthy diet when consumed in moderation.

### Chocolate is delicious and tasty

3. Chocolate is delicious and has a unique taste and palatability, with the special sensation of melting on the tongue. It is said to contain at least 300 natural chemical compounds, resulting in a complex range of tastes that connect with the human brain as it runs over the taste buds of our tongue. In addition to its nutritional properties, the fat and carbohydrate content of chocolate add to its appeal, through the enhancement of sweetness and texture. The slowly released energy and feelings of satisfaction induced by its sugar content and texture, improve energy levels and feelings of well being. The basic reason why people eat chocolate is because it tastes good.

## **COCOA, CHOCOLATE AND HEART HEALTH**

14. The cocoa bean contains a large number of phytochemicals, physiologically active compounds found in plants. One group of compounds is called polyphenols and they have been shown to have antioxidant properties. The most abundant polyphenols in cocoa beans are the flavanols. Flavanols are a sub-class of flavonoids. Flavanols are found in a variety of plant derived foods and beverages, including cranberries, peanuts, apples, onions, chocolate, tea and red wine. Different varieties of cocoa contain varying levels of flavanols and the way the chocolate is processed can also affect the level of flavanols in the final product. Different products, because they are made with different recipes will have different amounts of flavanols too. In general, however, dark chocolate has the highest amounts of flavanols because of its high cocoa content. In the processing of cocoa beans to make chocolate, some of the compounds with health benefits such as flavonoids can be destroyed due to temperature and chemical changes. However, having discovered the health benefits of these compounds, cocoa processors and chocolate manufacturers are beginning to adapt processing methods to minimize losses of these healthy compounds.

15. There is a growing body of evidence about the health benefits of cocoa flavanols. Flavanols are powerful antioxidants and are believed to help the body's cells resist damage by free radicals, which are formed by numerous processes including when the body's cells utilize oxygen for energy. Oxidative damage to the body's cells and tissues is believed to contribute to diseases such as heart disease. Cocoa beans are a good source of the flavanols, catechin and epicatechin and the more complex procyanidins, and the amounts present are often similar to or greater than those present in a variety of fruits and vegetables. Laboratory and human studies indicate that cocoa flavonoids can inhibit LDL cholesterol oxidation, thereby helping to prevent the build up of fibrous plaques on the arterial walls. In addition to this anti oxidant effect, cocoa flavonoids have other benefits as described below:

16. Researchers at the University of California, Davis, led by Dr. Carl Keen, have conducted numerous studies that suggest that consumption of certain flavanol-rich cocoa and chocolate may positively affect cardiovascular biomarkers. Consumption of a flavonoid-rich cocoa beverage by healthy humans was shown to inhibit platelet activity and increase the time taken for blood to clot. This could be important as increased platelet activation and aggregation (stickiness) leads to thrombosis and blockage of coronary arteries. Further research compared low-dose aspirin and a cocoa beverage rich in flavanols, and found reductions in platelet aggregation with both.

17. Other studies have found that cocoa flavonoids may benefit cardiovascular health by reducing pro-inflammatory enzymes, thereby reducing inflammation of blood vessels.

18. Research suggests that consumption of a cocoa rich in flavanols may be associated with the modulation of nitric oxide. Nitric oxide is produced in the lining of blood vessels. Its major functions include opening up the arteries to increase blood flow, maintain elasticity and prevent platelets from adhering to artery walls. These protective mechanisms are important for good cardiovascular health. Effects on nitric oxide may be responsible for possible beneficial effects of cocoa on blood pressure. An interesting observational study began with an inquiry into the difference between the isolated, island-dwelling Kuna Amerinds in Central America, who had a low tendency toward developing age-related hypertension, despite relatively high salt intakes, and Kuna who had migrated to Panama City on the mainland, who did develop hypertension with age. Further investigation discovered the indigenous Kuna consume large quantities of flavanol-rich cocoa.

19. More recently, a study in Italy compared the blood pressure of healthy subjects after consuming 100g dark chocolate daily for 15 days, compared with white chocolate providing the same number of calories. Systolic blood pressure was significantly lower with dark chocolate.

20. Studies have indicated that stearic acid, which is one of the main fatty acids in cocoa, is a unique long-chain saturated fatty acid (SFA) as it does not raise blood cholesterol. The reason for this is not fully understood but may in part be due to it being less well absorbed than other saturated fats. Studies on chocolate have also shown it to have a minimal effect on serum cholesterol and therefore not to increase the risk of coronary heart disease.

### **Cancer risk reduction**

21. Evidence is beginning to emerge to suggest that cocoa and chocolate may be able to contribute to reducing the risk of certain types of cancer. Research has shown that the reactive oxygen species (ROS) associated with the carcinogenic processes are inhibited by antioxidants, such as those found in cocoa and chocolate. Population studies have demonstrated that people with a regular intake of food containing antioxidants, such as vegetables, fruit, tea, or soy products displayed a lower incidence of various types of cancer. Based on the knowledge available, it can be deduced that the intake of antioxidants, including those from cocoa and chocolate, inhibit the several phases of the complex processes leading to cancer.

### **PSYCHOLOGICAL ATTRIBUTES OF COCOA AND CHOCOLATE**

22. The allure of chocolate and the love affair that people have with it makes chocolate stand out among other confectionery products. Children and adults like to be treated to chocolate and it is something most people enjoy and cherish. It is a universal gift for birthdays, special celebrations and holidays. It is mainly its unique taste and mouthfeel that gives people a feeling of emotional well-being. Chocolate can reduce stress and improve mood, and although a number of theories have been put forward none have been proven yet. There are unlikely to be sufficient levels of the various chemicals in chocolate to have the effects associated with pharmaceutical doses of those chemicals.

23. Cocoa and chocolate have been reported to enhance mental activity. Cocoa and chocolate contain substantial amounts of a class of biologically active compounds called methylxanthines, which include theobromine, caffeine and theophylline. These compounds cause physiological actions ranging from stimulation of the central nerve system (CNS), to stimulation of the cardiac muscle and relaxation of the muscles, in general. These compounds, especially caffeine, have effects on behaviour, mood and physical performance. The major methylxanthine in cocoa and chocolate is theobromine which is physiologically weaker than caffeine. Caffeine is present in relatively low amounts compared to coffee. The extent to which the consumption of cocoa and chocolate has an impact on these psychological effects is still being studied further.

24. Research results are inconclusive about the causes of craving reported among consumers of chocolate (chocolate lovers). Because chocolate tastes so good, and is often perceived as a treat, people often feel guilty about eating it. For this reason they often call their desire for it an addiction. The knowledge that chocolate contains psychoactive substances (e.g. theobromine, caffeine, phenylethylamine and tryptophan) supports their belief that it is addictive. However, a scientific review on this topic concluded that, given the low levels at which these substances are present in chocolate, there is no evidence that chocolate can affect the brain. Another hypothesis is that the carbohydrate in chocolate affects the levels of serotonin, a neurotransmitter, in the brain. Serotonin is thought to help people feel calm and relaxed. However there is little supporting evidence to support this. So-called 'addiction' is reported as often with milk chocolate although the protein levels would probably prevent the potential effects of carbohydrates on serotonin levels.

### **PERCEIVED HEALTH RISKS OF COCOA AND CHOCOLATE AND RESEARCH FINDINGS TO COUNTER THEM**

25. For many years chocolate has been associated with certain perceived health risks. Some people still believe in some of the traditional negative perceptions on chocolate, which associate chocolate with problems such as allergies, diabetes, dental caries, acne and migraines. Recently, serious problems with obesity in high-income countries, both among adults and children, have resulted in a number of people pointing the finger at chocolate, as one of the so called "junk" foods. Most if not all of these perceptions have been refuted by scientific research. The recent phenomenon of obesity on a large scale, including among children, requires further research.

#### **Chocolate and obesity**

26. As chocolate contains fat, carbohydrates and protein, it has – as indicated above - historically been used as an energy food, because of its high-calorie content. Obesity results from excess body fat that is stored because energy (calorie) intake exceeds usage. The frequent consumption of energy-dense foods accompanied by a sedentary lifestyle is likely to lead to a rapid gain of excess weight. Chocolate seems to have an association with the public and policy makers as a contributor to over-weight.

27. However, there is no scientific evidence to support the claim that chocolate consumption is associated with obesity. Studies have shown inverse, positive or no relationship between chocolate consumption and either overweight or obesity. Where relationships shown have been positive, these disappear when results are adjusted for physical activity or total energy intake. While research on this matter continues, at present the general conclusion is that obesity is not caused by any single food, but by overeating of any high energy food, resulting in a person's body being unable to balance energy intake with energy expenditure. In other words, the overall diet coupled with a lack of appropriate energy expenditure (exercise), is the underlying cause of most cases of obesity. Research findings on carbohydrate consumption and obesity indicate that there is an inverse relationship between diets high in carbohydrates, including sugar, and body fatness. Moderation in the consumption of chocolate, coupled with increased physical activity can be encouraged. Someone on a healthy diet can safely eat chocolate in moderation without fear of weight gain. To influence public opinion on this issue, it would seem desirable to further quantify and specify this statement.

### **Chocolate and allergies**

28. Food allergy, also referred to as food sensitivity, is a reaction by the body's immune system to a substance or ingredient in food, usually proteins. The most common allergenic foods are milk, eggs, peanuts, tree nuts, soy sauce, wheat, fish and shellfish. Chocolate is an uncommon food allergen and hardly any scientific publications relate chocolate to allergy. However, milk chocolate in particular is mixed with milk and other ingredients which may cause allergic reactions such as eggs and peanuts. The added ingredients, rather than the chocolate may be the cause of any reported problems.

### **Chocolate and diabetes**

29. As diabetes is a disorder of carbohydrate metabolism, characterized by high blood glucose levels, people with diabetes were, until a decade ago, advised to avoid simple sugars in order to better maintain their blood glucose (sugar) levels. The high sugar content of chocolate was the main reason why it was recommended to people with diabetes to avoid chocolate consumption. In the meantime, research has shown that people with diabetes can eat small amounts of chocolate without any significant adverse impact on their glucose control. This means that, contrary to earlier beliefs, the intake of carbohydrates does not need to be drastically reduced, but merely controlled. It is also important to note that chocolate has a low glycemic index (GI), which means that chocolate does not cause a sudden increase in blood sugar levels. However, many adults with Type 2 diabetes are overweight and so should modify their intake of all calorie dense foods.

### **Chocolate and dental caries (tooth decay)**

30. Tooth decay or dental caries occurs when bacteria in the mouth turn sugar into acids, which erode the tooth surface and cause cavities. Chocolate is no more implicated in the cause of tooth decay than any other food, which contains carbohydrates such as bread, potatoes, fruit, etc. However, chocolate melts very rapidly and thus remains in the mouth for a shorter period, reducing the time it stays in contact with the teeth. Hence it is less likely to cause tooth decay. Researchers have found that cocoa can protect against tooth decay. Certain substances, such as tannins and polyphenols, which naturally occur in cocoa, may play a role in the inhibition of dental plaque formation. Limited research suggests that they may limit the cariogenic potential of the sugar in chocolate. This finding has also led scientists to believe that some of these components found in cocoa might one day be added to mouthwash or toothpaste.

### **Chocolate and migraines**

31. There are no facts to support any relationship between chocolate consumption and migraines. Migraines are headaches caused by spasms of the arteries leading to the brain. The underlying mechanisms are still being studied. However, it is understood that a number of triggers seem to be needed to start the migraine process and certain foods, including chocolate, are commonly cited as triggers. Cases have been reported of chocolate precipitating headaches. However, in general, research shows that headaches and chocolate intake are not related. Experts seem to agree that headaches are usually caused by factors such as stress, irregular sleep patterns, hunger, and hormone changes. As these are times when chocolate is often consumed, it has led to it being wrongly thought to be a trigger for migraine.

### **Chocolate and acne**

32. *Acne vulgaris* is an inflammatory disease of the skin which leads to the formation of an eruption of papules or pustules. Studies have indicated that there is no evidence that food, including chocolate, has any direct role in the pathogenesis of acne. An extensive research review of chocolate and acne has suggested that chocolate ingestion is unrelated to the cause of acne. It has also become clear that the diet plays no role in acne treatment in most patients and that even large amounts of chocolate do not result in clinically aggravated acne.

### **CONCLUDING REMARKS**

33. Concerns over obesity presently seem to form the single most severe threat to consumption of chocolate, especially in rich countries where people and governments are trying to come to terms with this increasing public health problem. Consumption of certain types of food, including chocolate, is being blamed as the major cause of obesity. Obesity is now becoming a physical and mental health crisis. Many countries are already considering legislation to control the promotion and consumption of food that is perceived to contribute to overweight. For many people, chocolate belongs to that category of foodstuffs.

34. However, as clearly demonstrated above, chocolate consumption can be truly beneficial to human health. The greater the proportion of cocoa solids, in general the greater the benefits seem to be. The evidence backing the health benefits of chocolate continues to become stronger as researchers learn to understand better the positive health and nutritional attributes of cocoa and chocolate. There seems to be an urgent need to bring this information to consumers to increase the knowledge and awareness of the positive health attributes of cocoa and chocolate.

35. The most important message to be transmitted to consumers at present is that chocolate, when consumed in moderation, can form part of a wholesome, well balanced, health-promoting nutritional diet. ICCO, as an international non-profit making Organization, would seem to be well-placed to convey this message in a credible way. The message would have to be balanced and well-articulated.

36. The Promotion Committee may wish to develop ideas and suggestions to strengthen the message of the health and nutritional attributes of cocoa. In this respect, it could articulate ideas on the content of the message to consumers; and formulate suggestions for the format and strategy of a possible campaign to promote consumption by increasing awareness and knowledge of the health and nutritional properties of cocoa and chocolate.

## BIBLIOGRAPHY

Below is a reference list of some key published books, papers and reports related to the health and nutritional attributes of cocoa and chocolate.

1. Edited by I. Knight. *Chocolate and Cocoa: Health and Nutrition*. 1999
2. Waterhouse AL., Shirley JR, Donovan JL. Antioxidants in chocolate. *The Lancet* 1996; 348, 834.
3. Vinson JA, Proch J, Zubik L. Phenol antioxidant quantity and quality in foods: cocoa, dark chocolate, and milk chocolate. *J Ag Food Chem* 1999; 47: 4821-4824.
4. Wan, Y, Vinson JA, Etherton TD, Proch J, Lazarus SA, Kris-Etherton PM. Effects of cocoa powder and dark chocolate on LDL oxidative susceptibility and prostaglandin concentrations in humans. *Am J Clin Nutr* 2001; 74: 596-602.
5. Biscuit Cake Chocolate and Confectionery Association (2005). *Snackfacts: A nutrition science summary*
6. Keen C. L et al (2005). Cocoa antioxidants and cardiovascular health. *Am J Clin Nutr* 81:S298-S303
7. Grassi D et al (2005). Short-term administration of dark chocolate is followed by a significant increase in insulin sensitivity and decrease in blood pressure in healthy persons. *Am J Clin Nutr.* 81:611-614
8. Hunter K. A et al (2000). A residential study comparing the effects of diets rich in stearic acid, oleic acid, and linoleic acid on fasting blood lipids, hemostatic variables and platelets in young healthy men. *J Nutr. Biochem* 11:408-416
9. Kris-Etherton P M, Yu S (1997). Individual fatty acid effects on plasma lipids and lipoproteins: human studies. *American Journal of Clinical Nutrition*: 65: 1628S-1644S
10. Kris-Etherton P. M et al (1994). A milk chocolate bar/day substituted for a high-carbohydrate snack increase high density lipoprotein cholesterol in young men on a NCEP/AHA Step One Diet. *American Journal of Clinical Nutrition* 60: 1037S-1042S
11. Seinberg F et al (2003). Cocoa and Chocolate flavonoids: implications for cardiovascular health. *JADA* 103:215-223
12. Engler, M. et al. 2004. Flavonoid-Rich Dark Chocolate Improves Endothelial Function and Increases Plasma Epicatechin Concentrations in Healthy Adults *J. Am. Coll. Nutrition* 23: 197.
13. Kenny, T., et al. 2004. Pentameric Procyanidins Isolated from *Theobroma cacao* Seeds Selectively Down regulate ErbB2 in Human Aortic Endothelial Cells. *Experimental Biology and Medicine* 229: 255.

14. Kroon, P. et al. 2004. How should we assess the effects of exposure to dietary polyphenols in vitro? *Am. J. Clinical Nutrition* 80(1): 15.
15. Manach, C. et al. 2004. Polyphenols: food sources and bioavailability. *Am. J. Clinical Nutrition* 79: 727.
16. Mursu J. et al. 2004. Dark Chocolate Consumption Increases HDL Cholesterol Concentration and Chocolate Fatty Acids May Inhibit Lipid Peroxidation in Healthy Humans. *Free Radical Biology and Medicine* 37 (9): 1351-1359.
17. Steinberg, F., Bearden, M., and Keen, C. 2003. Cocoa and chocolate flavonoids: Implications for cardiovascular health. *Journal of the American Dietetic Association* 103:215.
18. Koga, T., and Meydani, M. 2001. Effect of plasma metabolites of (+)-catechin and quercetin on monocyte adhesion to human aortic endothelial cells. *Am. J. Clinical Nutrition* 73: 941.
19. Nestel, P. 2001. How good is chocolate? *Am. J. Clinical Nutrition* 74: 563.
20. Nijveldt, R. et al. 2001. Flavonoids: a review of probable mechanisms of action and potential applications. *Am. J. Clinical Nutrition* 74: 418.
21. Pearson, D., Schmitz, H., Lazarus, S., and Keen, C. 2001. Inhibition of in vitro low-density lipoprotein oxidation by oligomeric procyanidins present in chocolate and cocoas. *Methods Enzymology* 335:350.
22. Sanders, T., Oakley, F., Cooper, J. and Miller, G. 2001. Influence of a stearic acid-rich structured triacylglycerol on postprandial lipemia, factor VII concentrations, and fibrinolytic activity in healthy subjects. *Am. J. Clinical Nutrition* 73: 715.
23. Schramm, D. 2001. Chocolate procyanidins decrease the leukotriene-prostacyclin ratio in humans and human aortic endothelial cells. *Am. J. Clinical Nutrition* 73: 36.
24. Wan, Y. 2001. Effects of cocoa powder and dark chocolate on LDL oxidative susceptibility and prostaglandin concentrations in humans *Am. J. Clinical Nutrition* 74: 596.
25. Holt, R. 2002. Procyanidin dimer B2 [epicatechin-(4 $\beta$ -8)-epicatechin] in human plasma after the consumption of a flavanol-rich cocoa. *American Journal of Clinical Nutrition*. 76: 798.
26. Kris-Etherton, P., and Keen, C. 2002. Evidence that the antioxidant flavonoids in tea and cocoa are beneficial for cardiovascular health. *Current Opinion in Lipidology* 13: 41.
27. Mathur, S., Devaraj, S., Grundy, S., and Jialal, I. 2002. Cocoa Products Decrease Low Density Lipoprotein Oxidative Susceptibility but Do Not Affect Biomarkers of Inflammation in Humans. *Journal of Nutrition* 132: 3663.
28. Osakabe, N., Yasuda, A., Natsume, M., and Takizawa, T., 2002. Catechins and their oligomers linked by C4 C8 bonds are major Cacao polyphenols and protect low-density lipoprotein from oxidation In Vitro. *Experimental Biology and Medicine* 227:51.

29. Rios, L. 2002. Cocoa procyanidins are stable during gastric transit in humans. *American Journal of Clinical Nutrition* 76:1106.
30. Zhu, Q. et al. 2002. Inhibitory Effects of Cocoa Flavanols and Procyanidin Oligomers on Free Radical-Induced Erythrocyte Hemolysis. *Experimental Biology and Medicine* 227:321.
31. Lee, K., Kim, Y., Lee, H., and Lee, C. 2003. Cocoa has more phenolic phytochemicals and a higher antioxidant capacity than teas and red wine. *Journal of Agricultural and Food Chemistry* 51: 7292.
32. Mao, T. et al. 2003. Cocoa Flavonols and Procyanidins Promote Transforming Growth Factor- $\beta$ 1 Homeostasis in Peripheral Blood Mononuclear Cells. *Experimental Biology and Medicine* 228: 93.
33. Murphy, K. et al. 2003. Dietary flavanols and procyanidin oligomers from cocoa (*Theobroma cacao*) inhibit platelet function. *Am. J. Clinical Nutrition*. 77: 1466.
34. Rios, L. 2003. Chocolate intake increases urinary excretion of polyphenol-derived phenolic acids in healthy human subjects. *Am. J. Clinical Nutrition* 77: 912.
35. Taubert, D., Berkerls, R., Rosen, R., and Klaus, W. 2003. Chocolate and Blood Pressure in Elderly Individuals With Isolated Systolic Hypertension. *Journal of the American Medical Association*. 290: 1029 - 1030.
36. Kondo, K. et al. 1996. Inhibition of LDL oxidation by cocoa. *Lancet* 348:1514.
37. Waterhouse, A., Shirley, J., and Donovan, J. 1996. Antioxidants in chocolate. *Lancet* 348:834.
38. Sanbongi, C., Suzuki, N., and Sakane, T. 1997. Polyphenols in chocolate, which have antioxidant activity, modulate immune function in humans in vitro. *Cell Immunology* 177:129.
39. Arteel, G., and Sies, H. 1999. Protection against peroxynitrite by cocoa polyphenol oligomers. *Federation of European Biochemical Societies (FEBS) Letters* 462:167.
40. Arts, I., Hollman, P., and Kromhout, D. 1999. Chocolate as a source of tea flavonoids. *Lancet* 354:488.
41. Hammerstone, J., et al. 1999. Identification of procyanidins in cocoa (*Theobroma Cacao*) and chocolate using high-performance liquid chromatography/mass spectrometry. *Journal of Agricultural and Food Chemistry* 47:490.
42. Lazarus, S., Hammerstone, J. and Schmitz, H. 1999. Chocolate contains additional flavonoids not found in tea. *Lancet* 354:1825.
43. Mao, T., et al. 1999. The influence of cocoa procyanidins on the transcription of interleukin-2 in peripheral blood mononuclear cells. *International Journal of Immunotherapy* 15:23.
44. Richelle, M., Tavazzi, I., Enslin, M., and Offord, E. 1999. Plasma kinetics in man of epicatechin from black chocolate. *European Journal of Clinical Nutrition* 53:22.

45. Vinson, J., Proch, J., and Zubik, L. 1999. Phenol antioxidant quantity and quality in foods: cocoa, dark chocolate and milk chocolate. *Journal of Agricultural and Food Chemistry* 47:4821.
46. Duthie, G., and Crozier, A. 2000. Plant-derived phenolic antioxidants. *Current Opinion in Lipidology* 11:43.
47. Karim, M., McCormick, K., and Kappagoda, C. 2000. Effects of Cocoa Extracts on Endothelium-Dependent Relaxation. *Journal of Nutrition*. 130:2105S.
48. Mao, T., et al. 2000. Cocoa procyanidins and human cytokine transcription and secretion. *Journal of Nutrition* 130:2093S.
49. Mao, T., et al. 2000. The effect of cocoa procyanidins on the transcription and secretion of interleukin 1beta in peripheral blood mononuclear cells. *Life Sciences* 66:1377.
50. Raloff, J. 2000. Chocolate Hearts: Yummy and good medicine? *Science News* 157: 188.
51. Rein, D. 2000. Cocoa inhibits platelet activation and function. *Am. J. Clinical Nutrition* 72: 30.
52. Rein D. et al. 2000. Cocoa and wine polyphenols modulate platelet activation and function. *Journal of Nutrition* 130:2120S.
53. Spencer J. et al. 2000. Decomposition of cocoa procyanidins in the gastric milieu. *Biochemical and Biophysical Research Communications* 272:236.
54. Wang, J. et al. 2000. A dose-response effect from chocolate consumption on plasma epicatechin and oxidative damage. *Journal of Nutrition* 130:2115S
55. Grant JD, Anderson PC. Chocolate as a cause of acne: A dissenting view. *Missouri Med.* 1965;62:459-460.
56. Krummel D. Chocolate and food allergies: fact or fiction. *Immunology & Allergy Practice.* 1992;14(8):306/33-312/39.
57. Adamson G, Lazarus S, Amitchell A, Prior R, et al. HPLC method for the quantification of procyanidins in cocoa and chocolate samples and correlation to total antioxidant capacity. *J Am Chem Soc.* 1999.
58. Kondo K, Hirano R, Matsumoto A, et al. Inhibition of LDL oxidation by cocoa. *Lancet.* 1996;348:1514.
59. Kris-Etherton P and Wan Y. Fifth international symposium on chocolate and cocoa nutrition. Tokyo, Japan; Sept. 1999.
60. Hill AJ, Heaton-Brown L. The experience of food craving: a prospective investigation in healthy women. *J Psychosom Res.* 1994;38:801-14.

61. Willet WC. Dietary fat and obesity: an unconvincing relationship. *Am J Clin Nutr.* 1998;68:1149-1150.
62. Rolls, BJ. And Hill JO. Carbohydrates and weight management. 1998; International Life Sciences Institute, Washington, D.C.
63. Nutall, F. Q. and Gannon, M. C. Carbohydrates and diabetes. IN: Franz, M. J. and Battle, J. P., eds. American Diabetes Assoc. Guide to Medical Nutrition Therapy. Am. Diabetes Assoc. 1999; 85-106.
64. Apgar JL, Shively CA, Tarka SM. Digestibility of cocoa butter and corn oil and their influence on fatty acids distribution in rats. *J Nutr.* 1987;117:660-664.
65. Mitchell DC, McMahon KE, Shively, CA, Apgar JL, Kris-Etherton PM. Digestibility of cocoa butter and corn oil in human subjects: a preliminary study. *Amer J Clin Nutr.* 1989;50:983.
66. Bonanome, A, Grundy, SM, Effect of dietary stearic acid on plasma cholesterol and lipoprotein levels. *N Engl J Med.* 1988;318:1244-1248.
67. Kris-Etherton PM, Derr JA, Mitchell DC, et al. The role of fatty acid saturation on plasma lipids, lipoproteins and apolipoproteins. I. Effects of whole food diets high in cocoa butter, olive oil, soybean oil, dairy butter and milk chocolate on the plasma lipids of young men. *Metabolism.* 1993;42:121-129.
68. Derr JA, Kris-Etherton PM, Pearson TA, Seligson FH. The role of fatty acid saturation on plasma lipids, lipoproteins and apolipoproteins. II. The plasma total and LDL-cholesterol response of individual fatty acids. *Metabolism.* 1993;42:130-134.
69. Kris-Etherton PM, Derr JA, Mustad VA, Seligson FH, Pearson TA. A milk chocolate bar/day substituted for a high carbohydrate snack increases high density lipoprotein cholesterol in young men on an NCEP/AHA Step One diet. *Am J Clin Nutr supplement.* December 1994.
70. Cobb TK. Effects of dietary stearic acid on plasma cholesterol levels. *South Med J.* 1992;85:25-27.
71. Pearson, D.A., et al., *Flavanols and platelet reactivity.* *Clinical Developments in Immunology,* 2005. **12**: p. 1-9.
72. Schenker, S., *The nutritional and physiological properties of chocolate.* *BNF Nutrition Bulletin,* 2000. **25**: p. 303-313.
73. Sies, H., et al., *Cocoa polyphenols and inflammatory mediators.* *American Journal of Clinical Nutrition,* 2005. **81**: p. 304S-312S.

74. Bertrais, S., et al., *Contribution of confections to daily nutritional intakes in French adults: association with relative weight*. International Journal of Obesity, 2000. **24**(Suppl. 1): p. S53.
75. Muller, M.J., et al., *Prevention of obesity - more than an intention. Concept and first results of the Kiel Obesity Prevention Study (KOPS)*. international Journal of Obesity, 2001. **25**: p. S66-S74.
76. Danielzik, S., et al., *Parental overweight, socioeconomic status and high birth weight are the major determinants of overweight and obesity in 5-7 year-old children: baseline data of the Kiel Obesity Prevention study (KOPS)*. International Journal of Obesity, 2004. **28**: p. 1494-1504.
77. Koletzko, B., et al., *Nutrition in children and adolescents in Europe: what is the scientific basis? Introduction*. British Journal of Nutrition, 2004. **92**(Suppl 2): p. S67-S73.
78. Anderson, L.F., et al., *Overweight and obesity among Norwegian children: changes from 1993 to 2000*. Scandanavian Journal of Public Health, 2005. **33**: p. 99-106.
79. Bolton-Smith, C. and M. Woodward, *Dietary composition and fat to sugars ratios in relation to obesity*. International Journal of Obesity, 1994. **18**: p. 820-828.
80. Gibson, S.A., *Are high-fat, high-sugar foods conducive to obesity?* International Journal of Food Sciences and Nutrition, 1996. **47**: p. 405-415.
81. New, S.A. and D.A. Grubb, *Relationship between biscuit, cakes and confectionery consumption to body mass index and energy intake in Scottish women*. Proceedings of the Nutrition Society, 1996. **55**: p. 122A.
82. Gibson, S., J. Lambert, and D. Neate, *Associations between weight status, physical activity, and consumption of biscuits, cakes and confectionery among young people in Britain*. British Nutrition Foundation Bulletin, 2004. **29**: p. 301-309.
83. Janssen, I., et al., *Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns*. Obesity Reviews, 2005. **6**: p. 123-132.
84. Marcus, D.A., et al., *A double-blind provocative study of chocolate as a trigger for headache*. Cephalalgia, 1997. **17**: p. 855-862.
85. Rogers, P.J. and H.J. Smit, *Food craving and food "addiction": A critical review of the evidence from a biopsychological perspective*. Pharmacology Biochemistry and Behavior, 2000. **66**(1): p. 3-14.