Nutrition and Health Info Sheet: *Catechins and Epicatechins*

For Health Professionals

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What are catechins/epicatechins?

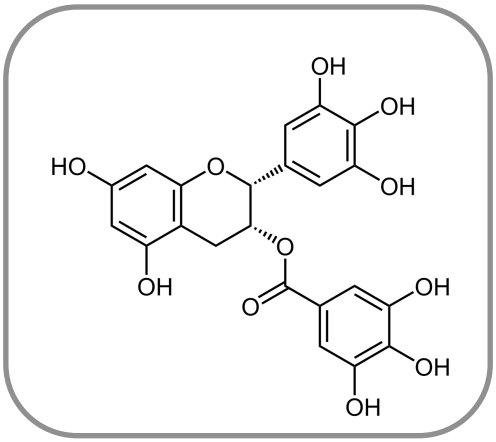

Figure 1: *Epigallocatechin gallate structure*
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Catechins and epicatechins are phytochemical compounds found in high concentrations in a variety of plant-based foods and beverages. Based on their structure, these compounds are classified as flavanols and include the following compounds: catechin, epicatechin, epigallocatechin, epicatechin gallate, and epigallocatechin gallate. High concentrations of catechin can be found in red wine, broad beans, black grapes, apricots and strawberries. Epicatechin concentrations are high in apples, blackberries, broad beans, cherries, black grapes, pears, raspberries, and cocoa/chocolate. Finally, epigallocatechin, epicatechin gallate, and epigallocatechin gallate are found in high concentrations in both black and green tea.[1]

Are there beneficial effects associated with consumption of catechins/epicatechins?

The consumption of foods rich in catechins and epicatechins has been associated with a variety of beneficial biological effects including increased plasma antioxidant activity (ability of plasma to scavenge free radicals), brachial artery dilation (blood vessel expansion), fat oxidation, and resistance of LDL to oxidation and promotion of gut health.[1] The gut microbiota can biotransform catechin and epicatechin, and conversely the presence of these nutrients in the gut can induce changes in gut microbial populations. It has been speculated that catechin/epicatechin can help inhibit production and activation of harmful bacteria while allowing beneficial bacteria to flourish.

There seems to be a lot of media hype around red wine, cocoa/chocolate, and tea. Are these really "super foods?"

As shown in the table on pages 5 and 6, red wine, chocolate, and tea are all high in catechins/epicatechins, in addition to a variety of other polyphenolic compounds.[2] The

following pages contain a summary of some of the recent research on the effects of consuming these foods

Red Wine

Numerous studies have investigated the relationship between consumption of red wine and susceptibility to certain chronic diseases including lung cancer, prostate cancer, and cardiovascular disease.

Cardiovascular disease: Consumption of red wine has been associated with a reduction in endothelin-1 (a molecule involved in blood pressure regulation), a reduction in myocardial ischemic reperfusion injury (an injury to the heart when blood is returned to the organ after a period of restriction), increased HDL concentrations, decreased platelet aggregation (clumping), increased fibrinolysis (breakdown of a clot), and increased plasma antioxidant activity.[4,5] Furthermore, results from some studies indicate that consumption of red wine may slow the progression of atherosclerosis.

Diabetes Mellitus: The flavanols in red wine may improve the lipid profile in some individuals. Insulin sensitivity and reduced insulin resistance has been reported to improve in individuals with moderate wine consumption.[5] In animal studies, increased HDL lipoproteins, lowered levels of ox-LDL, decreased platelet aggregation and improvements in endothelial function have been reported following moderate red wine consumption.[6] In a randomized study conducted on individuals with controlled Type II Diabetes, the catechins in the red wine were reported t significantly increase plasma HDL levels by 2.0 mg/dL.[7]

Lung Cancer: Research studies have focused on the correlation of COPD (Chronic Obstructive Pulmonary Disease) and increased lung cancer risk. The inflammatory response from oxidative stress exacerbates the side effects of COPD, and similarly increases an individual's' risk for lung cancer. Consistent with its putative antioxidant abilities, moderate consumption of red wine has been associated with a reduced risk of lung cancer in comparison to individuals who do not consume red wine.[8]

Prostate Cancer: There have been contradicting results regarding consumption of red wine and cancer. Results from some studies suggest that consumption of red wine over a lifetime posed increased risks of prostate cancer. Further research is needed to better understand the amount and time period of red wine consumption and the associated risks to prostate cancer.[9]

Conclusions: In light of this research, the American Heart Association does not recommend consumption of alcohol to reduce risk of cardiovascular disease and the American Cancer Society recommends limiting consumption of alcoholic beverages. If adults choose to drink alcoholic beverages, the Dietary Guidelines for Americans, 2015-2020 recommends they do so in moderation. Moderation is considered 1 drink (defined as 12 ounces of beer, 5 ounces of wine, 1.5 ounces of 80-proof spirits, or 1 ounce of 100-proof spirits) per day for women and 2 drinks per day for men.[10] Some short term research suggests that 100 percent purple grape juice may be an alcohol free alternative to red wine for those interested in the cardiovascular and anticancer effects of this beverage; however a reduction in development of chronic disease and mortality due to consumption of grape juice has yet to be confirmed.[11,12] If choosing to consume purple grape juice, it is important to follow the Dietary Guidelines for Americans, 2015-2020, and limit juice consumption by choosing whole fruit for the majority of your daily fruit servings.[8]

Chocolate

It has been suggested that the catechins/epicatechins in chocolate and cocoa may protect against coronary heart disease and stroke, through several proposed mechanisms.[14,15]

What is the antioxidant capacity of chocolate? (13)

Antioxidant capacity is the ability for a compound or compounds to reduce the concentration of free radicals in a given system.

Chocolate Type	Antioxidant Capacity (mmol Trolox Equivalents)
Cocoa Liqueur	
Per 100 g	40.0
Dark (Semisweet) Chocolate	
Per 100 g	13.1
Per 100 kcals	2.7
Milk Chocolate	
Per 100 g	6.7
Per 100 kcals	1.3

Cardiovascular disease: Consumption of flavanol-rich chocolate or cocoa has been associated with a variety of cardiovascular benefits including decreased LDL oxidation, decreased platelet aggregation, increased antioxidant capacity, decreased oxidative stress (an imbalance in the ratio of antioxidants to free radicals), increased HDL concentrations, increased levels of prostacyclin (a signaling molecule involved in the prevention of blood clot formation), decreased levels of leukotriene (a signaling molecule involved in inflammation and allergic reactions), increased nitric oxide production, improved endothelial function, lower systolic and diastolic blood pressure, improved insulin sensitivity, decreased insulin resistance, decreased free radical induced hemolysis (breakdown or red blood cells), improved brachial artery dilation, and decreased LDL cholesterol concentrations.[16]

Conclusions: The Dietary Guidelines for Americans 2015 recommends that the average person (who consumes 2,000 calories per day) consume no more than 270 calories outside the realms of nutrient dense foods (fat-free or low-fat

foods from the six core food groups of grains, vegetables, fruits, milk, meat and beans, and oils). These foods are regarded as "calories for other uses," or added fats and sugars.[10] In light of current cocoa/chocolate research, it may be beneficial to include a small piece of dark chocolate (equal to 30 calories) or a cocoa beverage as part of the daily discretionary calorie allotment.[17] While there may be several benefits to consuming flavanol-rich chocolate or cocoa in an overall healthy dietary pattern, this should be done in concert with the consumption of a a well-balanced diet that meets the dietary to repoteguidelines.

Tea

Tea has been consumed by Asian populations for thousands of years and is purported to have numerous beneficial effects on health. Research has investigated the relationship between tea and a variety of topics including cardiovascular disease, cancer, weight management, diabetes, Alzheimer's disease, and bone density.

Cardiovascular Disease: Epidemiological evidence suggests that consumption of tea is inversely associated with the risk for myocardial infarction (heart attacks).[18] Green or black tea flavonoids have been reported to have vasculoprotective (protection of blood vessels), antioxidative, antithrombogenic (prevention of blood clot formation), anti-inflammatory, and lipid-lowering properties, which may contribute the reduced risk of cardiovascular disease associated with tea consumption.[19]

Cancer: According to the American Cancer Society, consumption of green tea has been associated with a reduced risk of skin, esophagus, stomach, colon, pancreas, lung, bladder, prostate, and breast cancer in experimental models.[20,21]

Weight Management: The catechins present in green tea are proposed to work with caffeine as adjuvants in promoting increased fat oxidation and energy expenditure. The pairing of caffeine and catechins influences 24-hour energy expenditure via the sympathetic nervous system (SNS) and peripheral tissues. Research suggests that there is a correlation between this pairing and increased thermogenesis to burn more calories throughout the day and stimulate fat oxidation. This is achieved via upregulation of the certain lipid-metabolizing enzymes on pathways that further increases fat oxidation. Catechins present in tea may inhibit enzymes for decreased glucose uptake to focus on lipolysis. However, multiple findings suggested that the inhibition of enzymes by catechins sends a signal to increase the overall energy expenditure. It is important to note that these studies found that high protein consumption while consuming green tea may limit the effects of the catechins. The research suggests a substantial amount of green tea consumption is needed for increased benefits.[22,23] According to a recent randomized,

double blind clinical study, high dosage of EGCG extract over a twelve week period resulted in significant weight reduction, decreased total cholesterol and decreased LDL levels in Asian women with central obesity. High EGCG doses were also associated with increased energy metabolism and inhibit lipid accumulation, which require confirmation from future in vivo and in vitro studies for its mechanistic action.[24]

Type II Diabetes: Current research investigating the relationship between consumption of flavonoid-rich food and risk of Type II Diabetes has not found a significant relationship between tea consumption and risk of this chronic disease, other than potential improvements in lipid profiles.[25,26]

Alzheimer's Disease: Epidemiological research investigating Alzheimer's Disease does not show health benefits on human participants. However, research suggests that reduction in oxidative stress and inhibition of tumor growth can increase cognitive function and prolong the progression of Alzheimer's Disease.[27]

Bone Density: EGCG has been used to study the prevention of osteoporosis. Through the natural anti-inflammatory and anti-oxidative stress activities, EGCG proved to be beneficial in osteogenesis (bone formation). Studies focused on potential supplementary therapies of EGCG and Vitamin D to prevent or slow down the process of osteoporosis. Further research is needed to better understand EGCG's influence on osteoblast (bone cell) differentiation and the connection to increased bone density.[28]

Conclusions: Current research supports an inverse relationship between consumption of tea and risk of cardiovascular disease and loss of bone mineral density. In light of these findings, replacing a daily cup of coffee or caffeinated soda with a cup of unsweetened black or green tea may prove to be beneficial to overall health, but no specific recommendations regarding tea consumption can be made at this time. While there are many health benefits to consuming tea, addition of sugar, cream, and other caloric flavorings as well as calories that fall under the "calories for other uses" may take away from these benefits.

What is the catechin/epicatechin content of some common foods?[2]

Food	Catechin (mg/100g)	Epicatechin (mg/100g)	Epigallo-catechin, Epicatechin Gallate, & Epigallo-catechin Gallate (mg/100g)	Epigallo-catechin (mg/100g)	Epicatechin Gallate (mg/100g)	Epigallo-catechin Gallate (mg/100g)
Almonds	1.3	0.6	2.6	2.6	-*	-
Apples, raw with skin (Fuji)	0.8	5.6	3.0	1.1	-	1.9
Apples, raw with skin (Gala)	1.4	6.0	0.8	0.7	-	0.1

Food	Catechin (mg/100g)	Epicatechin (mg/100g)	Epigallo-catechin, Epicatechin Gallate, & Epigallo-catechin Gallate (mg/100g)	Epigallo-catechin (mg/100g)	Epicatechin Gallate (mg/100g)	Epigallo-catechin Gallate (mg/100g)
Apples,raw (Granny Smith)	1.9	7.1	0.9	0.7	-	0.2
Blackberries	37.1	4.7	0.7	0.1	-	0.6
Black Grapes	10.1	8.7	0.8	0.1	-	0.7
Brewed Black Tea	1.5	1.2	23.4	8.1	5.9	9.4
Brewed Green Tea	2.6	8.3	114.3	-	-	-
Brewed Green Tea, Decaffeinated	-	6.2	49.7	16.0	7.6	26.1
Broadbeans, immature seeds, cooked, drained, no salt	8.2	29.1	15.5	15.5	-	-
Blueberries	5.3	0.6	0.7	0	0	0.7
Cacao beans	88.5	99.2	-	156.7	-	-
Cherries	4.4	5.0	0.4	0.3	0.1	0
Cocoa mix, powder	21.5	31.2	-	-	-	-
Dark Chocolate	12.0	41.5	-	-	-	-
Fava Beans	8.2	7.8	4.7	-	-	-
Hazelnuts	1.2	0.2	-	2.8	-	1.1
Milk Chocolate	2.1	6.3	-	-	-	-
Oolong Tea, Brewed	0.2	2.5	47.0	6.1	6.3	34.6
Pears	0.3	3.8	0.8	-	-	-
Pecans	7.2	0.8	7.9	5.6	-	2.3
Pistachios	3.6	0.8	2.5	2.1	-	0.4
Plums, black diamond raw with peel	17.6	2.4	13.6	13.1	-	0.5

Food	Catechin (mg/100g)	Epicatechin (mg/100g)	Epigallo-catechin, Epicatechin Gallate, & Epigallo-catechin Gallate (mg/100g)	Epigallo-catechin (mg/100g)	Epicatechin Gallate (mg/100g)	Epigallo-catechin Gallate (mg/100g)
Raspberries	2-48	4.1	1.0	-	-	-
Strawberries, raw	3.1	0.4	1.1	0.8	0.2	0.1
Red Table Wine	8-30	3.3	0.1	-	-	-
Red Table Wine, Cabernet Sauvignon	7.7	11.1	-	-	-	-
White Wine	3.6	0.6	-	-	-	-

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