

Nutrition and Health Info Sheet: Phytochemicals

For Health Professionals

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What are phytochemicals?

Phytochemicals are bioactive compounds found in vegetables, fruits, cereal grains, and plant-based beverages such as tea and wine. Phytochemical consumption is associated with a decrease in risk of several types of chronic diseases due to in part to their antioxidant and free radical scavenging effects.¹ Recent research has also highlighted their potential role in improved endothelial function and increased vascular blood flow.²

What are the various types of phytochemicals?

About 10,000 different phytochemicals have been identified, and many still remain unknown.¹ Based on their chemical structure, phytochemicals can be broken into the following groups³, as shown below in Figure 1.

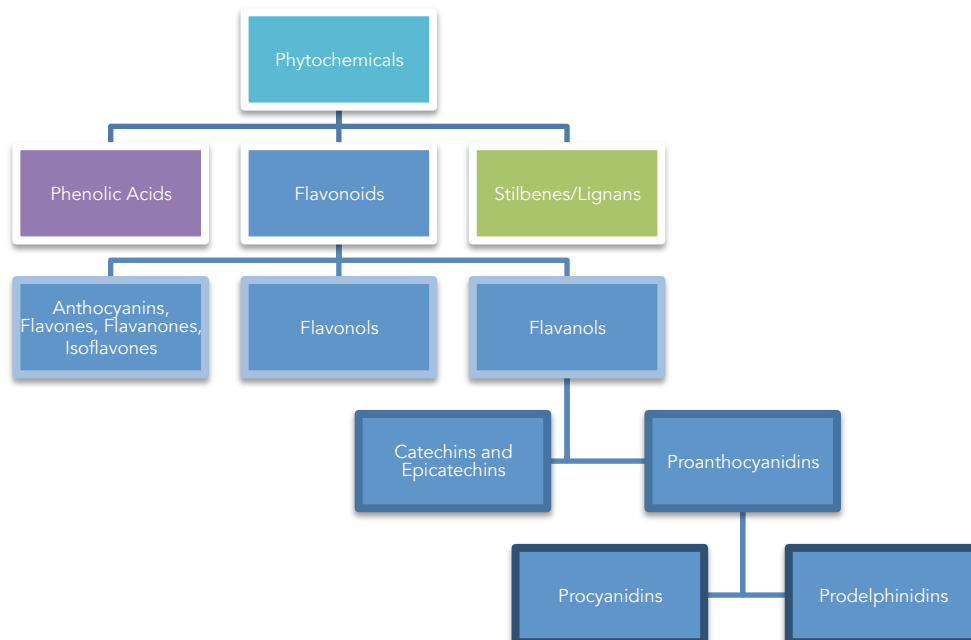


Figure 1: Types of Phytochemicals

What are flavonoids and why are they of particular interest?

Flavonoids make up the largest class of phytochemicals.² In general, flavonoids can play an important role in decreasing disease risk through various physiologic mechanisms. Some of these include antiviral, anti-inflammatory, cytotoxic, antimicrobial, and antioxidant effects.⁴ Mechanisms responsible for improvements in heart disease risk include improved endothelial function, decreased blood pressure, and improvements in lipid and insulin resistance.⁵ Flavonoids can be divided into the following subclasses flavonols, flavanones, flavones, flavan-3-ols, and flavanonols.⁶ Certain clinical studies have documented relationships between flavonoid consumption and decreased cancer risk. For example, research has shown a relationship between the reduction of colorectal cancer risk, which is the third most common type of cancer in the world, and the consumption of dietary flavonoids.⁶ Additionally, the Flaviola Health Study reported that cocoa flavanol intake can improve endothelial function in those with cardiovascular risk factors and disease. Through this study, intake of cocoa flavanol significantly predicted a lowering of 10-year risk for CHD, heart attack, CVD, and death from CVD or CHD in high risk subjects, as well as the potential to maintain health in low-risk subjects.⁵

What are some examples of flavonoids and their food sources?

| Class | Example | Common Food Source |
|---------------|------------|--|
| Flavonol | Quercetin | Citrus fruits, apples, onions |
| Flavanol | Catechin | Chocolate, tea, coffee |
| Isoflavone | Genistein | Lupin, fava beans, soybeans |
| Flavonone | Hesperetin | Citrus fruits: oranges, lemons, grapefruit |
| Anthocyanidin | Cyanidin | Berries |

What is the evidence that phytochemicals protect against disease?

Critical reviews of studies available in the literature support the concept that diets high in fruits and vegetables reduce the risk of hypertension, CHD, stroke, and other diseases evidenced by dose-response relationships.⁷ Several research groups have confirmed the critical role that can be played by phytochemicals in reducing the risk for several diseases such as cancer and inflammatory conditions.⁸ For example, recent research has cited various effects of phytochemical consumption on cancer prevention⁹, reduction in stroke risk¹⁰, and Type 2 Diabetes prevention.¹¹ Proposed mechanisms of action for these findings include inhibition of lipid oxidation, lipid-lowering effects, hypoglycemic- and insulin-lowering effects, antioxidant activity, anti-inflammatory activity, and anti-proliferative or apoptotic cell death activity.¹¹

Why is it important to eat a variety of plant-based foods?

Plant-based foods like fruits, vegetables, and grains, contain several bioactive phytochemicals which may decrease the risk of chronic diseases. The health effects attributed to the consumption of phytochemicals are primarily due to the synergistic actions of bioactive dietary components which include micronutrients and phytochemicals. It is largely accepted that the additive effects of the combinations of various phytochemicals in whole plant-based foods are shown to have stronger protective actions than single, isolated phytochemical compounds.¹¹

What are the potential health benefits from select phytochemical compounds?

| Food | Phytochemical | Possible Benefit |
|--|--|--|
| Soybeans and soy based products | Isoflavones (Genistein and Daidzein) | Decreased arterial stiffness. ¹² |
| Berries, red wine | Anthocyanins | Increase in Natural Killer (NK) cells, decrease in aortic systolic blood pressures, reduction in diastolic blood pressures and arterial stiffness. ¹³ |
| Grapes, apples, cocoa, red wine | Proanthocyanidins and flavan-3-ols | Increased endothelial function, decreased LDL oxidation, and reduction in blood pressure. ¹⁴ |
| Onion, garlic, leeks, olives, scallions | Sulfides and thiols | Decrease total LDL cholesterol. ¹⁵ |
| Tomatoes and tomato products, carrots, sweet potatoes, and various fruits and vegetables | Carotenoids such as lycopene, and beta-carotenes | Inhibits vasopressor activity through suppression of Reactive Oxygen Species (ROS) to reduce CVD risk. ¹⁶ |
| Cruciferous vegetables such as broccoli, cabbage, and kale | Isothiocyanates (sulforaphane) | Protection against some cancers, protection against neurodegeneration and CVD risk. ¹⁷ |
| Apples, onions, citrus fruits | Quercetin | Reduction in blood pressure, decrease in LDL oxidation, and decrease in inflammation. ¹⁸ |

What is the recommended intake of phytochemicals?

Quantitative recommendations for the antioxidants Vitamin C, Vitamin E, and selenium are supported by the Panel on Dietary Antioxidants and Related Compounds, Subcommittees on Upper Reference Levels of Nutrients and Interpretation of Uses of DRIs, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes within the Institute of Medicine. Beta-carotene and other carotenoids are discussed, but quantitative recommendations for their intake are not given at this time. Requirements for beta-carotene or other carotenoid intake cannot be established due to lack of understanding of the exact mechanisms of these nutrients and their importance to health. However, recommendations for increased consumption of carotenoid-rich fruits and vegetables are supported.¹⁹

Should people take phytochemical supplements?

Because it is hypothesized that the beneficial health effects observed from phytochemicals are related to the synergistic mixture of phytochemicals and other nutrients found in whole foods and its components, consumption of variety of plant-based foods is encouraged. In clinical studies, when phytochemicals are isolated from the food source and taken alone as a supplement, individual compounds studied do not have consistent preventive health effects. Furthermore, the efficacy and long-term safety of many bioactive compounds as dietary supplements, especially at pharmacologic doses, requires further study.¹¹

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References:

1. Zhang YJ, et al. Antioxidant Phytochemicals for the Prevention and Treatment of Chronic Diseases. *Molecules*. 2015 Nov 27;20(12):21138-56. doi: 10.3390/molecules201219753.
2. Du G, et al. Polyphenols: Potential source of drugs for the treatment of ischaemic heart disease. *Pharmacol Ther*. 2016 Jun;162:23-34. doi: 10.1016/j.pharmthera.2016.04.008.
3. Arts IC and Hollman PC. Polyphenols and disease risk in epidemiologic studies. *Am J Clin Nutr*. 2005 Jan;81(1 Suppl):317S-325S.
4. Somerville VS, et al. Effect of Flavonoids on Upper Respiratory Tract Infections and Immune Function: A Systematic Review and Meta-Analysis. *Adv Nutr*. 2016 May 16;7(3):488-97. doi: 10.3945/an.115.010538.
5. Sansone R, et al. Cocoa flavanol intake improves endothelial function and Framingham Risk Score in healthy men and women: a randomised, controlled, double-masked trial: the Flaviola Health Study. *Br J Nutr*. 2015 Oct 28;114(8):1246-55. doi: 10.1017/S0007114515002822.
6. Koosha S et al. An Association Map on the Effect of Flavonoids on the Signaling Pathways in Colorectal Cancer. *Int J Med Sci*. 2016 Apr 29;13(5):374-85. doi: 10.7150/ijms.14485.
7. Boeing H, et al. Critical review: vegetables and fruit in the prevention of chronic diseases. *Eur J Nutr*. 2012 Sep;51(6):637-63. doi: 10.1007/s00394-012-0380-y.
8. Thangapazham RL, et al. Phytochemicals in Wound Healing. *Adv Wound Care (New Rochelle)*. 2016 May 1;5(5):230-241.
9. Kotecha R, et al. Dietary phytochemicals and cancer chemoprevention: a review of the clinical evidence. *Oncotarget*. 2016 May 25. doi: 10.18632/oncotarget.9593.

10. Kim J, et al. Phytochemicals in Ischemic Stroke. *Neuromolecular Med.* 2016 May 18. doi: 10.1007/s12017-016-8403-0.
11. Xi P and Liu RH. Whole food approach for type 2 diabetes prevention. *Mol Nutr Food Res.* 2016 May 9. doi: 10.1002/mnfr.201500963.
12. Reverri EJ, et al. Soy provides modest benefits on endothelial function without affecting inflammatory biomarkers in adults at cardiometabolic risk. *Mol Nutr Food Res.* 2015 Feb;59(2):323-33. doi: 10.1002/mnfr.201400270.
13. McAnulty LS, et al. Six weeks daily ingestion of whole blueberry powder increases natural killer cell counts and reduces arterial stiffness in sedentary males and females. *Nutr Res.* 2014 Jul;34(7):577-84. doi: 10.1016/j.nutres.2014.07.002.
14. Hgel HM, et al. Polyphenol protection and treatment of hypertension. *Phytomedicine.* 2016 Feb 15;23(2):220-31. doi: 10.1016/j.phymed.2015.12.012.
15. Craig WJ. Phytochemicals: guardians of our health. *J Am Diet Assoc.* 1997 Oct;97(10 Suppl 2):S199-204.
16. Sung LC, et al. Lycopene inhibits cyclic strain-induced endothelin-1 expression through the suppression of reactive oxygen species generation and induction of heme oxygenase-1 in human umbilical vein endothelial cells. *Clin Exp Pharmacol Physiol.* 2015 Jun;42(6):632-9. doi: 10.1111/1440-1681.12412.
17. Libro R, et al. Natural Phytochemicals in the Treatment and Prevention of Dementia: An Overview. *Molecules.* 2016 Apr 21;21(4). doi: 10.3390/molecules21040518.
18. Amiot MJ, et al. Effects of dietary polyphenols on metabolic syndrome features in humans: a systematic review. *Obes Rev.* 2016 Jul;17(7):573-86. doi: 10.1111/obr.12409.
19. Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids: A Report of the Panel on Dietary Antioxidants and Related Compounds, Subcommittees on Upper Reference Levels of Nutrients and of Interpretation and Use of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Washington, D.C.: National Academy, 2000. Print.

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