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NUTRITION AND HEALTH INFO SHEET

Flavonols

KARRIE HENEMAN, Assistant Project Scientist, Department of Nutrition, University of California, Davis; **SHERI ZIDENBERG-CHERR**, UC Cooperative Extension Nutrition Science Specialist, Department of Nutrition, University of California, Davis

What are flavonols?

Flavonols are phytochemical compounds found in high concentrations in a variety of plant-based foods and beverages. Based on their structure, flavonols are classified as flavonoids and include the following compounds: quercetin, kaempferol, and myricetin. The specific amounts of flavonols in foods are affected by a range of factors including plant type and growth, season, light, degree of ripeness, food preparation, and processing. Despite these variables, high concentrations of flavonols can be found in apples, apricots, beans, broad beans, broccoli, cherry tomatoes, chives, cranberries, kale, leeks, pear, onions, red grapes, sweet cherries, and white currants (1).

What is the flavonol content of some common foods? (2)

Food	Quercetin (mg/100g)	Kaempferol (mg/100g)	Myricetin (mg/100g)
apples	4.27	0.02	0.00
apricots	2.08	0.00	0.00
beans	0.00	31.32	0.00
broad beans (fava beans)	0.55	0.35	0.00
broccoli	2.51	0.01	4.01
cherry tomatoes	2.76	0.10	0.00
chives	4.77	10.00	0.00
cranberries	15.09	0.09	6.78
kale	7.71	26.74	0.00
leeks	0.10	2.95	0.00
pear	4.51	0.00	0.00
onions	21.42	0.62	0.02
red grapes	1.38	0.00	0.01
sweet cherries	2.64	0.00	0.00
tea	2.74	0.88	0.89
white currant	2.68	0.17	0.18

Are there beneficial effects associated with consumption of flavonols?

Consumption of flavonols has been associated with a variety of beneficial effects including increased activity of erythrocyte superoxide dismutase (an antioxidant enzyme found in red blood cells), a decrease in lymphocyte DNA damage, a decrease in urinary 8-hydroxy-2'-deoxyguanosine (a marker of oxidative damage), and an increase in plasma antioxidant capacity (the ability to scavenge free radicals) (3).



There seems to be a lot of media hype around apples, broccoli, and cranberries. Are these really “super foods”?

As shown in the above table, apples, broccoli, and cranberries are all high in flavonols, in addition to a variety of other polyphenolic compounds. Below is a summary of the research on the effects of consuming these foods:

Apples

Studies have investigated the relationship between consumption of apples and susceptibility to chronic diseases such as cancer, cardiovascular disease, asthma, and diabetes (4).

- *Cancer*: A reduced risk of oral, pharynx, esophagus, colon, larynx, breast, ovary, and prostate cancer has been observed in individuals who consume greater than or equal to one apple a day in comparison to those who consume less (5). In support of these findings, previous research on in vitro systems has found that apple flavonoids can positively affect carcinogen bioactivation, cell-signaling, cell cycle regulation, angiogenesis (the formation of blood vessels), oxidative stress, and inflammation (5).
- *Cardiovascular Disease*: Consumption of apples has been associated with a reduced risk of cardiovascular disease, cardiovascular events, coronary mortality, and thrombotic stroke (4).
- *Asthma*: In adults, a reduced risk of asthma, bronchial sensitivity, and chronic obstructive pulmonary disease in addition to improved lung function (as measured by forced expiratory volume) has been associated with apple consumption (4).
- *Diabetes*: Apple consumption has also been associated with a reduced risk of type 2 diabetes. In comparison to women who did not consume apples, consumption of at least one apple per day was associated with a 28 percent reduced risk of this chronic disease (6).
- *Conclusions*: Current research supports an inverse relationship between consumption of apples and a variety of chronic diseases. In light of these findings, consuming an apple a day as part of your recommended intake of fruits and vegetables may prove to be beneficial to overall health; however, variety is important and apples should not be the sole fruit consumed by an individual.

Broccoli

Cruciferous vegetables are part of the plant family Brassicaceae, which includes broccoli in addition to cabbage, cauliflower, Brussels sprouts, turnips, and watercress. Consumption of this group of plant foods has been associated with a reduction in risk of several cancers including lung, breast, colorectal, and prostate (7).

- *Cancer*: Epidemiological evidence supports an inverse association between consumption of broccoli and breast cancer risk in premenopausal women (8), prostate cancer (9), bladder cancer in men (10), lung cancer in postmenopausal women, colon cancer in postmenopausal women, cancer of the respiratory tract, stomach cancer in men, cancer of the reproductive organs in women, and thyroid cancer (11).
- *Conclusions*: In light of this research, the American Cancer Society recommends consuming broccoli (in any form, although raw broccoli contains the most nutrients) as part of a balanced diet that includes foods from a variety of plant sources.

Cranberries

Cranberries are commonly touted as a remedy for treating urinary tract infections. Current research has also investigated the relationship between consumption of cranberry products and cancer and cardiovascular disease.

- *Urinary Tract Infections:* Current scientific evidence suggests that use of cranberry products can prevent new urinary tract infections, possibly through inhibition of bacterial adhesion to the urinary tract (12). However, caution is warranted as cranberry juice may interact with warfarin (a blood thinner), resulting in bleeding (13).
- *Cancer:* Despite promising findings in experimental models suggesting that cranberries can protect against breast, colon, prostate, lung, and other tumors (14), current research on humans does not provide evidence that consumption of cranberry products reduces risk of cancer (15).
- *Heart Disease:* There is limited clinical evidence showing that consumption of cranberry products can protect against cardiovascular disease, possibly by decreasing LDL oxidation and increasing plasma antioxidant capacity (16).
- *Conclusions:* The Dietary Guidelines for Americans, 2005, recommend limiting consumption of juice to ensure adequate intake of fiber (31 grams per 2,000 kilocalories). (See the metric conversion table at the end of this publication.) For women prone to urinary tract infections, consuming $\frac{1}{2}$ cup of cranberry juice daily may help to reduce the number of new infections. As with apples and broccoli, current scientific evidence supports consumption of cranberry products as part of a varied diet.

METRIC CONVERSIONS

English	Conversion factor for English to metric	Conversion factor for metric to English	Metric
grain	64.80	0.015	milligram (mg)
fluid ounce (fl oz)	29.57	0.034	milliliter (ml)
ounce (oz)	28.35	0.035	gram (g)
cup	236.6	0.004	milliliter (ml)

REFERENCES

1. Aherne, S. A., and N. M. O'Brien. 2002. Dietary flavonols: Chemistry, food content, and metabolism. *Nutrition* 18:75–81.
2. United States Department of Agriculture (USDA). 2007. USDA database for the flavonoid content of selected foods. USDA Nutrient Data Laboratory Web site, http://grande.nal.usda.gov/nal_display/index.php?info_center=4&tax_level=2&tax_subject=279&topic_id=1387.
3. Williamson, G., and C. Manach. 2005. Bioavailability and bioefficacy of polyphenols in humans. II. Review of 93 intervention studies. *Am J Clin Nutr* 81:243S–255S.
4. Boyer, J., and R. H. Liu. 2004. Apple phytochemicals and their health benefits. *Nutr J* 3:5.
5. Gallus, S., R. Talamini, A. Giacosa, M. Montella, V. Ramazzotti, S. Franceschi, E. Negri, and C. La Vecchia. 2005. Does an apple a day keep the oncologist away? *Ann Oncol* 16:1841–1844.

6. Song, Y., J. E. Manson, J. E. Buring, H. D. Sesso, and S. Liu. 2005. Associations of dietary flavonoids with risk of type 2 diabetes, and markers of insulin resistance and systemic inflammation in women: A prospective study and cross-sectional analysis. *J Am Coll Nutr* 24:376–384.
7. Juge, N., R. F. Mithen, and M. Traka. 2007. Molecular basis for chemoprevention by sulforaphane: A comprehensive review. *Cell Mol Life Sci* 64:1105–11027.
8. Ambrosone, C. B., S. E. McCann, J. L. Freudenheim, J. R. Marshall, Y. Zhang, and P. G. Shields. 2004. Breast cancer risk in premenopausal women is inversely associated with consumption of broccoli, a source of isothiocyanates, but is not modified by GST genotype. *J Nutr* 134:1134–1138.
9. Kirsh, V. A., U. Peters, S. T. Mayne, A. F. Subar, N. Chatterjee, C. C. Johnson, and R. B. Hayes. 2007. Prospective study of fruit and vegetable intake and risk of prostate cancer. *J Natl Cancer Inst* 99:1200–1209.
10. Michaud, D. S., D. Spiegelman, S. K. Clinton, E. B. Rimm, W. C. Willett, and E. L. Giovannucci. 1999. Fruit and vegetable intake and incidence of bladder cancer in a male prospective cohort. *J Natl Cancer Inst* 91:605–613.
11. Verhoeven, D. T., R. A. Goldbohm, G. van Poppel, H. Verhagen, and P. A. van den Brandt. 1996. Epidemiological studies on brassica vegetables and cancer risk. *Cancer Epidemiol Biomarkers Prev* 5:733–748.
12. Jepson, R. G., and J. C. Craig. 2007. A systematic review of the evidence for cranberries and blueberries in UTI prevention. *Mol Nutr Food Res* 51:738–745.
13. Pham, D. Q., and A. Q. Pham. 2007. Interaction potential between cranberry juice and warfarin. *Am J Health Syst Pharm* 64:490–494.
14. Neto, C. C. 2007. Cranberry and its phytochemicals: A review of in vitro anti-cancer studies. *J Nutr* 137:186S–193S.
15. Duthie, S. J., A. M. Jenkinson, A. Crozier, W. Mullen, L. Pirie, J. Kyle, L. S. Yap, P. Christen, and G. G. Duthie. 2006. The effects of cranberry juice consumption on antioxidant status and biomarkers relating to heart disease and cancer in healthy human volunteers. *Eur J Nutr* 45:113–122.
16. Ruel, G., S. Pomerleau, P. Couture, B. Lamarche, and C. Couillard. 2005. Changes in plasma antioxidant capacity and oxidized low-density lipoprotein levels in men after short-term cranberry juice consumption. *Metabolism* 54:856–861.

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