

Flavonoid Content of Vegetables

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Abstract

Flavonoids are biologically active polyphenolic compounds widely distributed in plants. Intake of flavonoids may be associated with decreased risk of cancer, cardiovascular and inflammatory diseases in humans. Vegetables are one source for flavonoid compounds in the diet. USDA's Nutrient Data Laboratory evaluated the quality of existing literature values for flavonoids from sources around the world and compiled a database containing five subclasses (flavonols, flavones, flavanones, flavan-3-ols, and anthocyanidins) of flavonoids. Fifty-eight different vegetables, 28 herbs and edible leaves, and 4 vegetable recipes were included as part of the development of the USDA Flavonoid Database for Foods (http://www.nal.usda.gov/fnic/foodcomp). Many vegetables, including onions, hot peppers, broccoli, snap beans, kale, and lettuce contain flavonol compounds quercetin and kaempferol. Onions, followed by lettuce are the major vegetable contributors of quercetin to the diet, while broccoli is the major contributor of kaempferol. Broadbeans and marrowfat peas provide catechins, the flavan-3-ols. Parsley, rutabagas and celery provide high levels of apigenin, a flavone. Parsley, followed by celery are the major vegetable contributors of apigenin to the diet. In compiling the database, analytically valid data were assigned confidence codes (A=most confidence, D=least confidence) based on the quality of the sampling procedures, sample handling, analytical methods, and analytical quality control. While there were no A quality data for any flavonoid values for vegetables in the database, most vegetables had B or C quality data. This database is the first step in evaluating the need and directing research for obtaining new analytical data on the flavonoid content of vegetables.

Introduction

Food sources of flavonoids are vegetables, fruits, nuts, seeds, roots, and beverages like tea and wine. The USDA Database for the Flavonoid Content of Selected Foods, released in March 2003, contains information on the most prevalent dietary flavonoids. These are organized into five subclasses based on their chemical structure:

- **FLAVONOLS:** Quercetin, Kaempferol, Myricetin, Isorhamnetin
- **FLAVONES:** Apigenin, Luteolin
- **FLAVANONES:** Hesperetin, Naringenin, Eriodictyol
- **FLAVAN-3-OLS:** Catechins, Epicatechins, Theaflavins, Thearubigins
- **ANTHOCYANIDINS:** Cyanidin, Delphinidin, Malvidin, Pelargonidin, Peonidin, Petunidin

Data on the flavonoid content of vegetables was compiled from the scientific literature and evaluated using the Nutrient Data Laboratory's data quality evaluation system (Holden et al., 2002). Ratings based on sampling plan, sample handling procedures, number of samples, analytical method and analytical quality control were combined to yield a Confidence Code for each flavonoid value. The database, available on the website, contains the Nutrient Databank Number for individual foods, mean value for each flavonoid measured (mg/100g), standard error, minimum and maximum values reported, and the Confidence Code. This presentation summarizes the flavonoid content of vegetables, herbs, and vegetable recipes contained in this new database.

Table 1. Flavonoid content of vegetables

Vegetable	Flavonols Quercetin Kaempferol Myricetin Isorhamnetin	Flavones Apigenin Luteolin	Flavan-3-ols Catechins Epicatechins Theaflavins Thearubigins
Beans, kidney	*		*
Beans, snap	*		
Beets	*	*	
Broadbeans, fava			***
Broccoli	**		
Brussels sprouts	*	*	
Cabbage	*	*	
Carrots	*		
Cauliflower	*	*	
Celeriac	*	*	
Celery hearts, green		***	
Celery	*	**	
Cucumber	*		
Endive	*		
Gourd, dishcloth	*	*	
Kale, Chinese		*	
Kale	***		
Kohlrabi	*	*	
Leeks	*		
Lettuce	*	*	
Marrowfat peas			**
Onions, yellow or white	***		
Onions, spring	***		
Onions, red	****		
Parsley	*	****	
Parsnips	*		
Peas, green	*		
Peppers, hot	***	*	
Peppers, sweet	*	*	
Potatoes	*		
Radishes	*		
Rutabagas	***	**	
Spinach	**	*	
Tomatoes	*		
Tomato juice	*		
Tomato puree	*		
Turnip greens	**		
Waterspinach	*	*	
Watercress	**		

Vegetables with no detectable flavonoids: Mushrooms

Table 2. Flavonoid content of vegetable products and recipes

Vegetable products and recipes	Flavonols Quercetin Kaempferol Myricetin Isorhamnetin	Flavones Apigenin Luteolin
Pasta sauce (tomato based)	*	
Greek spinach pie	***	**
Tomato soup	*	

Vegetable products and recipes with no detectable flavonoids: Sauerkraut



Table 3. Flavonoid content of fresh herbs, edible leaves and roots

Herbs, Edible Leaves and Roots	Flavonols Quercetin Kaempferol Myricetin Isorhamnetin	Flavones Apigenin Luteolin
Annual saw thistle leaves	***	***
Chives	**	*
Coriander leaves	**	
Corn poppy leaves	**	*
Crown daisy leaves	*	*
Dill weed	****	
Dock leaves	****	
Fennel leaves	****	*
Garlic chives	*	
Hartwort leaves	**	*
Horseradish root	*	*
Loveage leaves	****	
Oregano		*
Parsley	*	****
Peppermint		***
Perilla leaves	*	*
Queen Anne's lace leaves	*	**
Rosemary		***
Sweet potato leaves	**	*
Tarragon	**	
Thyme		****

Herbs and edible leaves with no detectable flavonoids: Basil, chicory, lemon balm leaves, licorice root, purslane and sage.

Key: * < 5mg/100 g; ** 5 to <10 mg/100 g;
 *** 10 to < 50 mg/100 g; and **** 50+ mg/100 g.

Summary

- Flavonol compounds quercetin, kaempferol and myricetin are widely prevalent in vegetables. Particularly good sources are onions, hot peppers, kale, broccoli, rutabagas and spinach. Onions, lettuce, tomatoes, celery, hot peppers, spring onions, and broccoli are also major contributors of flavonol compounds to the diet.
- Legumes are the only vegetables which contain flavan-3-ol compounds catechins and epicatechins.
- Many herbs and edible leaves contain high levels of flavonols and flavones.
- Parsley contains very high amounts of apigenin, a flavone. Celery hearts and rutabagas are other vegetable sources of this flavonoid. Major contributors of apigenin to the diet are: Parsley, celery and lettuce.
- Thyme is very high in luteolin, another flavone. Luteolin is also present in beets, Brussels sprouts, cabbage and caluliflower. Major contributors of luteolin to the diet are: Celery, chili peppers, sweet pepper, lettuce and spinach.
- Red potatoes and red onions are the only vegetables in the database for which anthocyanidins were reported.
- Vegetables do not supply flavanones, although eriodictyol is high in peppermint.

This literature review has identified a number of gaps in our knowledge of the flavonoid content of vegetables:

- No flavonoid values have been published for many common vegetables consumed in the U.S., such as asparagus, corn, various greens, squash, lima beans, okra, etc.
- Many of the flavonoid analyses available were performed using foods purchased outside of the U.S. and may not reflect values for foods available in this country.
- For many foods there are only single values.
- There are no analytical methods to separate and quantify all the major flavonoids from all the classes simultaneously. As a result, many researchers only analyze one class of flavonoids in a particular food.

Analysis of commonly consumed vegetables for flavonoid compounds is underway as part of the National Food and Nutrient Analysis Program. These data will be used to revise and update the existing database as well as addressing some of the gaps identified by this research.