



Flavonoid Content of Vegetables: The USDA's Flavonoid Database

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Abstract

Flavonoids are biologically active polyphenolic compounds widely distributed in plants. Flavonoid intake may be associated with decreased risk of some chronic degenerative diseases in humans. Vegetables are one source for flavonoid compounds in the diet. USDA's Nutrient Data Laboratory evaluated existing literature from sources around the world and compiled a database containing flavonoid values for 58 different vegetables, 28 herbs and edible leaves, and 4 vegetable recipes as part of the development of its Flavonoid Database for Foods (<http://www.nal.usda.gov/fnic/foodcomp>). Many vegetables, including onions, hot peppers, broccoli, snap beans, kale, and lettuce contain flavonoid compounds quercetin and kaempferol. Broadbeans and marrowfat peas provide catechins, the flavanols. Parsley, rutabagas and celery provide high levels of apigenin, a flavone. In compiling the database, analytically valid data were assigned a confidence code (A=most confidence, D=least confidence) based on the quality of the sampling procedures, analytical methods and 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, the data quality rating and the Confidence Code. This presentation summarizes the flavonoid content of vegetables, herbs, and vegetable recipes contained in this new database.

Holden J, M.; Bhagwat, S.A., Patterson, K.Y. Development of a multi-nutrient data quality evaluation system. *J. Food Comp. Anal.* (2002) 15(4):339-348.

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

Vegetables with no detectable flavonoids: Mushrooms

Vegetable Products and Recipes	Flavonols	Flavones
	Quercetin Kaempferol Myricetin Isorhamnetin	Apigenin Luteolin
Pasta sauce (tomato based)	i	
Greek spinach pie	i i i	i i
Tomato soup	i	

Vegetable products and recipes with no detectable flavonoids: Sauerkraut



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

Herbs and Edible Leaves with no detectable flavonoids: Basil, Chicory, Lemon balm leaves, Licorice root, Purslane, Sage

Key: i < 5mg/100 g; i i 5 to < 10 mg/100 g; i i i 10 to < 50 mg/100 g; and i i i i 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.
- 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.
- Thyme is very high in luteolin, another flavone. Luteolin is also present in beets, Brussels sprouts, cabbage and cauliflower.
- 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 augment the values in the current database and address some of the gaps identified by this research.