USDA's Flavonoid Database: Flavonoids in Fruit

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Abstract

Learning outcome: To be able to identify rich sources of flavonoids in fruits.

Flavonoids are biologically active compounds found in plants that have been associated with decreased risk of some age related and chronic diseases in humans. Food composition data from literature published around the world were evaluated to compile USDA's Flavonoid Database (http://www.nal.usda.gov/fnic/foodcomp). Data are presented for 26 individual flavonoids in five subclasses based on their chemical structure: flavonols, flavones, flavanones, flavan-3-ols, and anthocyanidins. This database can be used to quantify the intake of flavonoids as well as to identify areas where additional research is needed to complete flavonoid profiles for commonly consumed foods. There are 78 raw and processed fruits and juices in the database. Citrus fruits are the only foods in which flavanones (hesperetin, naringenin, and eriodictyol) occur, except for in peppermint. Flavones (apigenin, luteolin) do not occur in significant quantities in fruit. Flavan-3-ols (catechins and epicatechins) are present in apples, cherries, and cranberries. Flavonols (quercetin, kaempferol, myricetin, and isorhamnetin) are present only in very small quantities in fruit. Literature data on anthocyanidins (cyanidin, delphinidin, malvidin, pelargonidin, peonidin, and petunidin), which are expected to be present in red/purple colored fruit, are available for only blueberries, cherries, elderberries, and raspberries. Analytical data have been generated to provide anthocyanidin values for these additional fruits: apples, blackberries, cranberries, red grapefruit, red grapes, plums, strawberries and watermelon.

Introduction

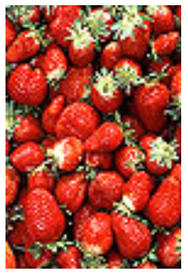
Food sources of flavonoids are vegetables, fruits, nuts, seeds, roots, and beverages like tea and wine. The USDA Database for the Flavonoid Content of Selected Foods, released in March 2003, contains information on the most prevalent dietary flavonoids. These are organized into five subclasses based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

- FLAVONOLS: Quercetin, Kaempferol, Myricetin, Isorhamnetin
- FLAVONES: Apigenin, Luteolin
- FLAVANONES: Hesperetin, Naringenin, Eriodictyol
- FLAVAN-3-OLS: Catechin, Gallocatechin, Epicatechin, Epicatechin 3-gallate, Epigallocatechin, Epigallocatechin 3-gallate, Theaflavin, Theaflavin-3,3'-digallate, Theaflavin-3'-gallate, Theaflavin-3-gallate, Thearubigins
- ANTHOCYANIDINS: Cyanidin, Delphinidin, Malvidin, Pelargonidin, Peonidin, Petunidin

Data on the flavonoid content of fruits 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 fruits contained in this new database. Additional samples of commonly consumed fruits were obtained from USDA's National Food and Nutrient Analysis Program (NFANP). Nationwide samples were collected and analyzed by USDA's Food Composition Laboratory (FCL). Anthocyanidin values from this study are indicated in red in the table.

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.*

	Anthocyanidins: Cyanidin, Delphinidin, Malvidin, Pelargonidin, Peonidin, Petunidin	Flavan-3-ols: Catechins [1], Epicatechins [2], Theaflavins [3], Thearubigins	Flavonols: Quercetin, Kaempferol, Myricetin, Isorhamnetin	Flavones: Apigenin, Luteolin	Flavanones: Hesperetin, Naringenin, Eriodictyol
Apples, with skin	★★	★★	★	•	
Apples, without skin	★	★★	★		
Applesauce, canned		★★	★	•	
Apple juice		★	★	•	
Apricots		★★★	★	•	
Apricots, canned			•	•	
Avocados	★				
Bananas	★★	•			
Bilberries			★		
Blackberries	★★★★	★★★	★		
Blood orange juice			•	•	★★★
Blueberries	★★★★	★	★		
Blueberries, frozen			★★		
Cherries, sour	★★				
Cherries, sweet	★★★★	★★★	★	•	
Cherries, sweet, canned		★	★	•	
Chokeberries, frozen			★★		
Cloudberries, frozen			★		
Cowberries			★★★		
Cranberries	★★★★	★	★★★		
Cranberry juice, raw		★	★★★		
Cranberry juice cocktail		★	★		
Crowberries, frozen			★★★		
Crowberry juice			★★		
Currants, black		★	★★★		
Currants, black, juice			★		
Currants, dried		•	•		
Currants, red		★	★	•	
Currants, white		★	★		
Elderberries	★★★★		★★★		
Gooseberries		★	★		
Grapefruit			★		★★★★
Grapefruit juice, canned					★★★
Grapefruit juice, frozen concentrate, diluted					★★★
Grapefruit juice, pink			•	•	★★★
Grapefruit juice, white			★	•	★★★
Grapes, black		★★★	★	•	
Grapes, black, juice		★			
Grapes, red		★	★		
Grapes, white or green		★	★	•	
Grape juice, canned		★	★	•	
Kiwifruit	•	★			
Lemons			★	★	★★★
Lemon juice, canned					★★★
Lemon juice, raw			★	•	★★★
Limes			★		★
Lime juice			★	•	★★★
Lingonberries			★★★		
Lingonberry juice			★		



	Anthocyanidins: Cyanidin, Delphinidin, Malvidin, Pelargonidin, Peonidin, Petunidin	Flavan-3-ols: Catechins [1], Epicatechins [2], Theaflavins [3], Thearubigins	Flavonols: Quercetin, Kaempferol, Myricetin, Isorhamnetin	Flavones: Apigenin, Luteolin	Flavanones: Hesperetin, Naringenin, Eriodictyol
Mangos		★			
Nectarines	★	★			
Olives, ripe, canned		•			
Oranges	•	•			★★★
Orange juice, chilled					★★
Orange juice, frozen concentrate, diluted					★★★
Orange juice, raw			★	•	★★★
Peaches	★	★	•	•	
Peaches, canned		★	•	•	
Pears, with skin	★★★	★	★	•	
Pears, without skin		★			
Pears, without skin, cooked		★			
Pineapples	•	•			
Plums	★★★	★★	★	•	
Pummelo juice			•	★	★★★
Raisins, seedless	•	★			
Raspberries	★★★	★★	★		
Rhubarb stalks, cooked		★			
Rhubarb stalks, raw		★			
Rowanberries			★★		
Sour orange, juice			•	•	★★★
Strawberries	★★★	★	★		
Strawberries, frozen			★		
Tangelo juice			•	•	★★★★
Tangerine juice			★	•	★★★
Tangor juice			•	•	★★★
Watermelon	•				

Key: • 0; ★< 5 mg/100 g; ★★ 5 to <10 mg/100 g; ★★★ 10 to < 50 mg/100 g; and ★★★★ 50+ mg/100 g; blank indicates lack of data. Red symbols indicates new data from FCL.

[1] Catechins: Catechin, gallocatechin

[2] Epicatechins: Epicatechin, epicatechin 3-gallate, epigallocatechin, epigallocatechin 3-gallate

[3] Theaflavins: Theaflavin, theaflavin-3,3'-digallate, theaflavin-3'-gallate, theaflavin-3-gallate

Summary

- Anthocyanidins are particularly high in blackberries, blueberries, cranberries, cherries, and elderberries. All contain >80 mg/100 g. Elderberries are the highest at 749 mg/100g. Cyanidin is the predominant or only anthocyanidin in most fruits. The only other foods in the database that contain anthocyanidins are wine and red onions.
- Citrus fruits are the only fruits that contain flavanones. The only other food in the database containing flavanones is peppermint, which contains eriodictyol and hesperetin.
- Fruits do not contain flavones, except for small amounts in lemons and pummelo juice.
- Many of the flavonoid analyses available from the scientific literature were from foreign sources and may not be representative of foods available in the United States.
- The database is being updated to include new data from FCL and the scientific literature published since the original database was prepared.
- The database is available on NDL's Web site: http://www.nal.usda.gov/fnic/foodcomp