

# Second Update of the “USDA Database for the Flavonoid Content of Selected Foods”

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## Abstract

The scientific community's interest in flavonoids continues and a large volume of analytical data is published in the peer reviewed journals. About 300 articles were collected since the second release of the USDA's Flavonoids Database in January 2007. Two hundred and eleven articles had either no analytical data (methodology, health-related studies, reviews) or data that could not be used for various reasons (values on dry weight basis, values for total flavonoids only etc.). The remaining 104 articles will be evaluated for the data quality and the acceptable data will be entered into the data files and the data will be aggregated with the previous data for the third release of the database. The Nutrient Data Laboratory (NDL) is modifying the USDA's data quality evaluation system (DQES) by adding a category "food description" to the existing five categories: sampling plan, sample handling, number of samples, analytical method, and analytical quality control. The NDL is also revising the rating points assigned to each category in accordance with the significance of the category. The new data will be evaluated using the modified system and the old data will be reevaluated for the additional category of "food description" and the ratings will be adjusted to reflect this change. The updated database will be released on the NDL's web site ([www.ars.usda.gov/nutrientdata](http://www.ars.usda.gov/nutrientdata)) with quality indicators and references for the data sources.

## Methods

- To obtain data in the literature that could be used, performed literature searches using key words for flavonoid subclasses and compounds presented below:
  - FLAVONOLS: Quercetin, Kaempferol, Myricetin, Isorhamnetin
  - FLAVANONES: Apigenin, Luteolin
  - FLAVANONES: Hesperetin, Naringenin, Eriodictyol
  - FLAVANS: Catechins, Epicatechins, Theaflavins, Thearubigins
  - ANTHOCYANIDINS: Cyanidin, Delphinidin, Malvidin, Pelargonidin, Peonidin, Petunidin
- Articles were retrieved and screened for analytical data for flavonoids in foods
- Articles with analytical data were further screened to eliminate publications that had:
  - Data for experimental foods prepared in the laboratory (non-commercial);
  - Data for "Total flavonoids" or totals for any subclass of flavonoids such as total anthocyanins (i.e., no data for individual flavonoid compounds);
  - Unacceptable analytical methods used (pH differential, thin layer chromatography, etc.) for analysis;
  - Data reported on dry weight basis without giving moisture content.
- All acceptable data were converted into aglycone forms using molecular weights and reported as mg/100g including beverages adjusted by using specific gravities
- New and old data were combined and aggregated by food to update the flavonoids database
- Format of the database was changed to make it consistent with the National Nutrient Database for Standard Reference (SR). Foods are now grouped by Food Groups, not alphabetically as in the earlier releases.
- Data quality evaluated by using USDA's original DQES (Holden et al., 2002, 2005) and confidence codes (CC) were assigned to all data points. Only new data were evaluated for the additional category of "food description" and by applying ratings (Table 1) for each category modified from earlier releases. Effects of the additional category on confidence codes were observed.

**Table 1. Old and New DQES Ratings**

Category	Old Rating	New Rating
Sampling Plan	20	20
Sample Handling	20	15
Analytical Method	20	25
Analytical Quality Control	20	15
Number of Samples	20	15
Food Description	-	10



**Table 2. Literature Review Screening**

Description of Articles	Number of Articles
Total number of articles	<b>315</b>
Unacceptable analytical data (values for totals of a subclass, values on dry weight basis without moisture content, unacceptable method (TLC, pH differential etc.), experimental foods (not available commercially))	<b>122</b>
Qualitative articles (analytical methods for identification, validation etc., no values)	<b>14</b>
General reviews on flavonoids and health benefits	<b>40</b>
Health-related epidemiological studies	<b>35</b>
Number of articles with acceptable analytical data	<b>104</b>

**Table 3. Data Quality Results**

Confidence Code	No. of Data points
A	204
B	2079
C	1240
D	147



**Table 4. Effect of Food Description Category on Confidence Codes**

Confidence Code	No. of Data points	
	Old	New
A	-	-
B	42	156
C	775	838
D	203	26

**Table 5. Some New Foods and Flavonoid values in the Updated Database**

Food Description	Flavonoid Compound	Quantity (mg/100g)
Acai berries, purple flesh Service (Saskatoon) berries	Cyanidin	53.6
	Cyanidin	111.1
	Delphinidin	50.4
	Malvidin	11.0
	Peonidin	3.0
Cabbage, Savoy, raw	Petunidin	6.3
	Quercetin	16.1
	Apigenin	0.7
	Luteolin	0.2
	Kaempferol	0.8
Mustard Greens, raw	Myricetin	0.1
	Quercetin	0.4
	Isorhamnetin	16.2
	Kaempferol	38.3
Radicchio, raw	Quercetin	8.8
	Cyanidin	127.0
	Delphinidin	7.7
	Luteolin	38.0
	Quercetin	31.5

## Results

### Literature Review:

Table 2 summarizes the description of articles collected since the last release of the USDA's flavonoids database in 2007.

### Data Quality Evaluation:

Approximately 3,670 individual records were evaluated for the data quality and CCs were assigned. Table 3 summarizes the number of records that were assigned A, B, C, and D confidence codes, "A" being the record with the highest confidence.

### Effect of "Food Description" Category on Confidence Codes:

- Approximately 1,020 individual records for new data were evaluated for data quality for five categories (sampling plan, sample handling, number of samples, analytical method, and analytical quality control) and assigned CCs by the old rating system.
- These records were also evaluated under the additional "Food Description" category and assigned CCs using the modified rating system as shown in Table 1. Table 4 illustrates the effect of adding "Food Description" category on the number of records for each CC group to the CC.
- Records with CC of B almost tripled (from 42 to 156), while records with CC of D reduced considerably (from 203 to 26).

### 3<sup>rd</sup> Release of the Flavonoids Database:

Approximately 115 new foods will be added to the updated database making the total of approximately 500 foods. The values for some of the new foods are given in Table 5.

- Foods will now be grouped by "Food Groups" instead of reporting them in an alphabetical order. Flavonoids are mainly present in the Fruits, Vegetables and Legumes groups and their products.
- For each food, analytical values for individual compounds have been grouped into five subclasses of flavonoids mentioned above. All the subclasses may not be included in all the foods if compounds from a particular subclass were not present in that food or no values were available.
- Analytical values will be reported as mg/100 g of fresh weight of aglycones of flavonoids. A separate table of glycoside values as reported by the authors of the articles will be available on the NDL's web site [www.ars.usda.gov/nutrientdata](http://www.ars.usda.gov/nutrientdata).

## Introduction

Flavonoids are secondary plant metabolites with various biological activities.

38 studies conducted worldwide have used USDA's flavonoids (monomeric), isoflavones, and proanthocyanidins (polymeric) databases to estimate flavonoids intakes to study their effects on reducing the risks of various chronic diseases like cardiovascular diseases and cancers.

- Lam et al. (2010) observed an inverse relationship between quercetin-rich food intake and lung cancer in a large case-control study in the Lombardi region of Italy.
- Rossi et al. (2010) observed strong inverse association between proanthocyanidin (PA) intakes and stomach cancer in a case-control study in the Greater Milan area of Italy.
- In a review on "future of flavonoid research", Kay (2010) recommended the need for a more comprehensive flavonoids database including effects of processing on food flavonoids.

Analytical data on flavonoids in foods has been published in peer-reviewed journals since the second update of the USDA's flavonoids database released in 2007.

- The Nutrient Data Laboratory (NDL) had collected more than 300 articles since the second release yielding 226 articles with analytical data.
- In an effort to harmonize the USDA's data quality evaluation system (DQES) with the European Food Information Resource (EuroFIR) network system NDL has added a category of "Food Description" to the existing five categories: sampling plan, sample handling, number of samples, analytical method, and analytical quality control.
- Ratings of other categories were adjusted to accommodate an additional category and the effects of additional food description category on the confidence codes (CC), the indicators of data quality, were observed.

## Summary

- The 3<sup>rd</sup> release of the "USDA's Database for the Flavonoid Contents of Selected Foods" will contain analytical values for approximately 500 foods for five subclasses of flavonoids. The database will be released on the NDL's web site. ([www.ars.usda.gov/nutrientdata](http://www.ars.usda.gov/nutrientdata))
- The addition of "Food Description" category to the DQES elevated the data quality scores for both the records with C and D confidence codes considerably. Therefore the inclusion of this category in the rating scheme for the DQES needs to be considered carefully. The addition of this category could be used as one way to provide an objective evaluation of the food description and to determine if the food should be included in the database.

## References

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