USDA Develops a Database for Flavonoids to Assess Dietary Intake

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Abstract

The Nutrient Data Laboratory (NDL) of ARS/USDA issued "USDA Database for the Flavonoid Content of Selected Foods, Release 3.0" in 2011. It contains values for 26 monomeric flavonoid compounds for 500 foods. A complementary database for the "Isoflavones Content of Selected Foods, Release 2" was issued in 2008. It contains values for daidzein, genistein, and glycitein for 557 foods. To support the assessment of the intake of monomeric flavonoids and isoflavones, values were imputed for approximately 3000 foods in USDA's National Nutrient Database for Standard Reference (SR). Many foods, particularly animal products do not contain flavonoids; a value of zero was used for the various flavonoids for these items. Within the five subclasses of flavonoids, some are found only in particular taxonomic species—the values for the other classes were assumed to be zero. Various estimation techniques, long established for imputing missing values in SR, were used to complete the database. This subset of the SR database will be used as the basis for estimating flavonoid values for foods in the USDA Food and Nutrient Database for Dietary Studies (FNDDS). The expanded FNDDS for flavonoids and isoflavones will be used by the Food Surveys Research Group (FSRG) of ARS to estimate intakes of these compounds in the U.S. population; collaborators will assess the relationship of flavonoid intake to levels of various indicators of health status.

Introduction

There is a considerable interest in the scientific community about the potential benefits of flavonoids in reducing risk of chronic diseases including cardiovascular diseases (Schroeter et al., 2011). Evidence supporting cancer prevention effects of flavonoids is limited and conflicting, but some organ-specific associations have been reported. Lam et al., (2010) observed inverse relationship between quercetin-rich food intake and lung cancer in Italy, while Ekström et al., (2010) observed protection against stomach cancer with high intakes of quercetin in a population study in Sweden. Flavonoids, including isoflavones, are secondary plant metabolites and are found mainly in fruits, vegetables, soybeans and some grains. The USDA database for the flavonoid content of selected foods, Release 3.1, contains values for up to 26 monomeric flavonoid compounds in five subclasses of flavonoids for 500 foods. The isoflavones database released by the USDA in 2008 contains values for three prominent compounds (daidzein, genistein, and glycitein) for 557 foods. The Nutrient Data Laboratory (NDL) developed a provisional database by expanding these two databases to include all foods used in the FNDDS, a total of about 3000 food items. Fruits and vegetables are the main sources of dietary flavonoids. Some grains like barley and buckwheat contain some catechins and flavonols. Isoflavones are mainly present in soybeans and soybean products such as soy flour, soymilk, tofu etc. Animal products such as meat/poultry do not contain any flavonoids, unless flavonid containing ingredients are added. Every food (fruit or vegetable) does not contain every compound from all subclasses. Quercetin, a flavonol, is the most ubiquitous flavonoid. Most of the foods contain compounds predominantly from one of the subclasses and from the subclass flavonols. For example: citrus fruits contain mainly flavanones, while tea contains mainly flavan 3-ols.

Methods

There are approximately 500 foods in each of the two databases (Flavonoids, 2011 and Isoflavones, 2008). The available values for the compounds for each food from these databases were matched by using the Nutrient Data Bank (NDB) number, a five digit numerical code used in the SR for a unique food item. It was necessary to impute missing values to prepare a complete profile for 29 flavonoids for each food in the FNDDS.

Estimation techniques for imputing missing values:

The NDL estimation techniques for imputing missing values (Schakel et al., 1997) were adopted as follows:

1. Assumed "0" values were assigned to all the meat/poultry products.
2. If compounds from a subclass of flavonoids were not expected in a food, "0" values were assumed for those compounds, e.g. "0" values for flavanones for most of the vegetables.
3. Used flavonoid values from a different, but similar food.
4. Calculated flavonoid values from a different form (raw/cooked or fresh/dry) of the same food using food yield (i.e. weight changes) and "compound" retention factors. Due to lack of experimental studies on flavonoid retentions, the NDL consulted the analytical chemists at the Food Composition and Methods Development Laboratory (FCMDL) of ARS/USDA to develop best approximations for the retention factors for flavonoids. The retention factors of 85% for all the subclasses except anthocyanidins and 50% for anthocyanidins were used whenever necessary.
5. If plant based ingredients, e.g. fruits or vegetables contributed <5% by weight to a multicomponent food, "0"values were assumed for all the flavonoids for that food.

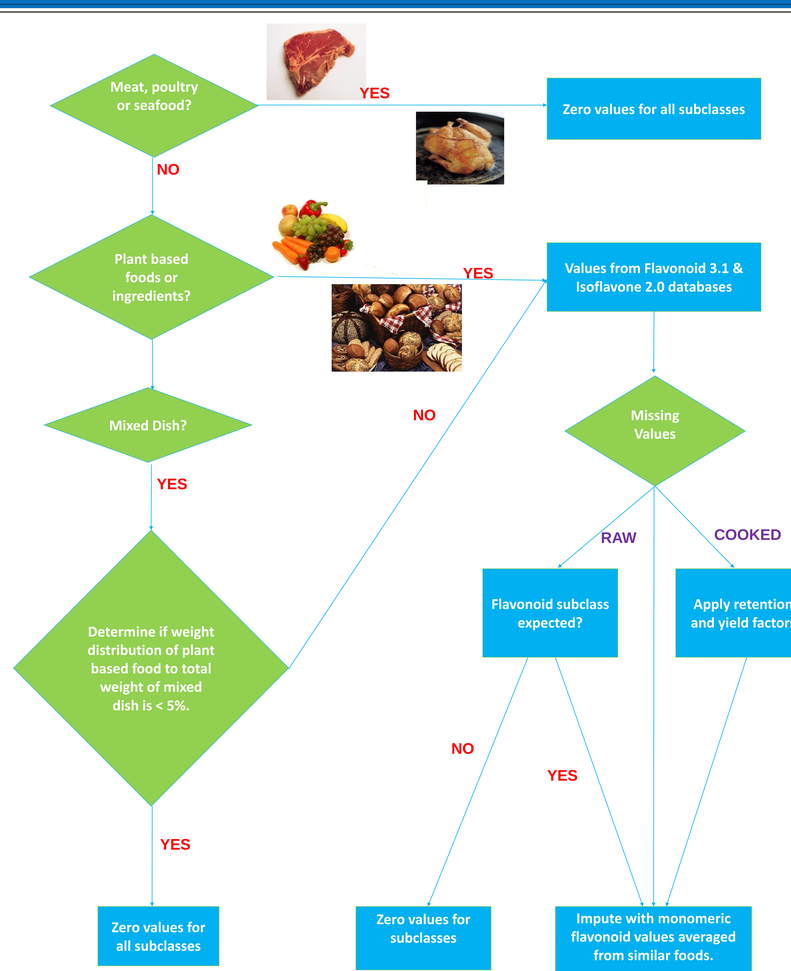

Figure 1. Decision Tree for Flavonoid Imputation

Table 2: Assignment of Zero Values by Food Group and Subclass

Food Groups (USDA Food Groups)	Flavonoid Subclass
Dairy and Egg Products (01)	Flavones Flavanones Anthocyanidins
Spices and Herbs (02)	Anthocyanidins Flavan-3-ols
Nuts and Seed Products (12)	Flavones Flavanones
Legumes and Legume Products (16)	Flavones Flavanones
Poultry (05) Sausages, Luncheon Meats (07) Pork Products (10) Beef Products (13) Finfish and Shellfish Products (15) Lamb, Veal, Game (17)	Flavonols Flavones Flavanones Flavan-3-ols Anthocyanidins

Results

The database for a subset of about 2900 foods with a complete profile for 29 flavonoids compounds will be completed in April 2012.

The FSRG will expand this database to provide flavonoid profile for all the foods in the FNDDS; the FNDDS will then be used to estimate intakes of these compounds in the U.S. population participating in the What We Eat in America (WWEIA) 2007-2008 and also National Nutrition and Health Examination Survey (NHANES) III. The collaborators will then assess the relationship of flavonoid intake to levels of various indicators of health status.

Table 1. **Flavonoid Subclasses and Food Sources**

Subclass	Compounds	Color	Food Sources
Anthocyanidins	Cyanidin, Delphinidin, Malvidin, Pelargonidin, Peonidin, Petunidin	Blue, Red, Violet	Berries (blueberries, Red grapes, Strawberries)
Flavanols	Catechin, Epicatechin, Gallocatechin, Epicatechin gallate, Epigallocatechin gallate, Theaflavins, Thearubigins	Colorless Yellow	Apples, Tea, Beer
Flavanones	Hesperetin, Naringenin, Eriodictyol,	Colorless Pale Yellow	Citrus fruits Oranges, Grapefruit
Flavonols	Quercetin, Kaempferol, Myricetin, Isorhamnetin	Pale Yellow	Onions, Broccoli, Kale, Apple, Tea, Buckwheat
Flavones	Apigenin, Luteolin	Pale Yellow	Herbs, Parsley, Thyme, Celery
Isoflavones	Daidzein, Genistein, Glycitein	Colorless	Legumes (soybeans), soybean products (tofu, soymilk)

Yao et al., 2004, Plant Foods for Human Nutrition, 59:113-122.

Table 3. Imputation of missing values from Similar Foods

Missing Values		Similar Foods		
NDB No.	Food Description	NDB No. for Imputation	Food Description	Factor used for Calculation (Reason)
11012	Asparagus, cooked, boiled, drained	11011	Asparagus, raw	85% (Retention Factor); Yield Factor (negligible)
11234	Kale, cooked	11161	Collard, raw	85% (Retention Factor); Yield Factor (negligible)
09110	Mulberries, raw, Anthocyanidins	09042	Blackberries, raw	Same values (negligible moisture difference)
02031	Spice, pepper, red or cayenne	99369	Cayenne pepper, raw	9.08 (Moisture Factor)
02027	Oregano, dried	99115	Oregano, fresh	3.18 (Moisture Factor)

References

1. Schroeter et al., Mol. Aspects Med., 2010, 31, 546-557.
2. Lam et al., Carcinogenesis, 2010, 31, 634-642.
3. Ekström et al., Annals of Oncology, 2011, 22, 438-443.
4. Schakel et al., J. Food Comp. Anal., 1997, 10, 102-114.