Composition of Foods
Raw, Processed, Prepared

USDA National Nutrient Database for Standard Reference, Release 27

Documentation and User Guide

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Contents

Introduction

The USDA National Nutrient Database for Standard Reference (SR) is the major source of food composition data in the United States. It provides the foundation for most food composition databases in the public and private sectors. As information is updated, new versions of the database are released. This version, Release 27 (SR27), contains data on 8,618 food items and up to 150 food components. It replaces SR26 issued in August 2013.

Updated data have been published electronically on the USDA Nutrient Data Laboratory (NDL) web site since 1992. SR27 includes composition data for all the food groups and nutrients published in the 21 volumes of "Agriculture Handbook 8" (US Department of Agriculture 1976-92), and its four supplements (US Department of Agriculture 1990-93), which superseded the 1963 edition (Watt and Merrill, 1963). SR27 supersedes all previous releases, including the printed versions, in the event of any differences.

In July 2001, when NDL converted to a new version of its Nutrient Databank System (NDBS), formats were changed and fields added to improve the descriptive information for food items and the statistical information about the nutrient values. While data in previous releases have been moved to the new NDBS, they may not have been updated through the complete system. Therefore, many of these new fields contain data only for those items that have been processed through the new NDBS and it will take a number of years before they are populated for all food items in the database.

As part of this upgrade and in various modifications to the NDBS performed since then, various checks have been built into the system to ensure data integrity and quality control. Additional checks are performed after the SR files have been disseminated from the NDBS. These checks include making sure that, to the extent possible, all fields are complete. Another check is to make sure that various calculations are completed and correct, such as calculating carbohydrate by difference; calculating energy by multiplying protein, fat and carbohydrate by the appropriate factors; and calculating vitamin A from individual carotenoids. Other checks include making sure that values for related nutrients are complete. For example, if there are individual fatty acids, there should also be values for total saturated fatty acids, total monounsaturated fatty acids, and total polyunsaturated fatty acids. With some adaptation, the procedures described in FAO/INFOODS Guidelines for Checking Food Composition Data prior to the Publication of a User Table / Database (FAO/INFOODS, 2012) and Ahuja and Perloff (2008) have been used. Nutrient values are also compared from release to release to make sure any changes in the values can be explained. Reasons for these changes include new data generated by the National Food and Nutrient Analysis Program (NFNAP) analyses or provided by manufacturers, reformulations by the manufacturer, better food sampling, and changes in weighting based on market share data. Quality control procedures associated with the analytical data are described in the discussion of NFNAP under Notes on Foods (p. 54).

Data have been compiled from published and unpublished sources. Published data sources include the scientific literature. Unpublished data include those obtained from the food industry, other government agencies, and research conducted under contracts initiated by USDA's Agricultural Research Service (ARS). These contract analyses are currently conducted under NFNAP, in cooperation with the National Cancer Institute (NCI) and other offices and institutes of the National Institutes of Health (Haytowitz *et al*., 2008), the Centers for Disease Control and Prevention, and the Food and Drug Administration. Data from the food industry represents the nutrient content of a specific food or food product at the time the data is sent to NDL. The values may change due to reformulations or other processing changes by individual companies between the time that SR is released and the next update of SR. Values in the database may be based on the results of laboratory analyses or calculated by using appropriate algorithms, factors, or recipes, as indicated by the source code in the Nutrient Data file. Every food item does not contain all of the nutrients/components released in SR.

Notes on Foods has been included in the documentation, starting with SR23 (2010), and has been placed after the references. When the earlier paper copies of Agriculture Handbook No. 8, Composition of Foods: Raw, Processed, Prepared were released in separate sections by food group, each contained a section called Notes on Foods. The Notes gave additional information about the foods, such as the definitions of lean and fat for meats or enrichment for grain products. For some food groups, a brief description of research projects conducted to generate nutrient data were described. For those food groups, where Notes on Foods are not included herein, the original versions are available in the printed "Agriculture Handbook 8" sections (US Department of Agriculture, 1976-92).

Specific Changes for SR27

A number of studies either conducted through NFNAP or by collaboration with various groups resulted in various changes to the database. The major changes to the database since the last release are listed below.

- Nutrient profiles were added for new foods and existing nutrient profiles were updated for SR27 using data generated by USDA through the NFNAP, submitted by the food industry, or using other publically available data. A complete list of the added food items can be found in the ADD_FOOD file and the updated nutrients in the CHG_NUTR file. The formats of these files can be found on p. 41.

  A major focus of this effort is to monitor those foods which are major contributors of sodium to the diet. The Food Surveys Research Group (FSRG), in collaboration with NDL, identified a group of select foods, termed 'Sentinel Foods', to be monitored as primary indicators for assessing change in the sodium content of foods in US food supply. In many cases, to reduce the sodium content of a food, the product must be reformulated using new ingredients or a different balance of ingredients, potentially affecting concentrations of nutrients other than sodium. Examples are fat, sugars, fiber, potassium, and fatty acids. Concentrations of

these nutrients are also being monitored. The results of these analyses have been used to update nutrient profiles for foods in SR. An additional 1,300 foods, mainly commercially packaged and restaurant foods with added sodium used in the national dietary survey What We Eat in America (WWEIA), National Health and Nutrition Examination Survey (NHANES) are being monitored through information obtained directly from manufacturers or restaurant chains and their websites or changes in the Nutrition Facts Panel values. If there was an appreciable change in the sodium value, or any of the other aforementioned nutrients, SR was updated as needed.

- Foods added or updated include: Breakfast cereals, fried chicken pieces (breast, thigh, and wing) and skin and breading; fast food biscuit; chicken strips; hash browns; chicken noodle condensed soup; fried shrimp (from restaurant); several pulses (chickpeas, green and red lentils, and green peas); a number of vegetarian items; deli-style roast beef; enhanced and non-enhanced pork loin chops; rotisserie chicken breast; Italian-style meatballs; turkey bacon; popular juice smoothies and fortified juice products; greek yogurt; sorghum grain and flour; green tea; energy drinks and other beverages.

- A number of pizzas, served at school lunches, have been added.

- Foods from Mexican and Italian casual dining and full service restaurants were added. Added Mexican restaurant items include: cheese enchilada, cheese quesadilla, cheese tamales, soft beef tacos, refried beans and spanish rice. Added Italian restaurant items include: cheese ravioli, chicken parmesan, lasagna, spaghetti with meat sauce, and spaghetti with pomodoro sauce.

- A study was conducted to update nutrient data on ground beef, reflecting current market trends. For more details see Notes on Foods for Beef Products (p. 66).

- A study was conducted in collaboration with Colorado State University (CSU) to obtain nutrient information for 7 representative retail veal cuts. For more information, see Notes on Foods for Lamb, Veal, and Game Products (p. 85).

- In collaboration with the New Zealand Meat Industry Association, a study was undertaken to determine nutrient composition of imported New Zealand beef and lamb cuts and offal items which are available in retail grocery stores in the US. For more details, see Notes on Foods for Beef Products (p. 72), and for Lamb, Veal, and Game (p. 85).

- A study was undertaken in collaboration with Cornell University to determine the nutrient content of ruffed grouse and Canada goose. For more information see Notes on Foods for Poultry Products (p. 122).

- A Glossary of Cooking Methods for Meat and Poultry Items was created, to provide definitions for methods used in USDA studies when cooking meats and poultry prior to nutrient analysis. The Glossary is available in Appendix C.

- Products such as mixed dishes, soups and breakfast cereals which are no longer on the market or without current data have been removed. A complete list of deleted food items can be found in the DEL_FOOD file. The format of the file is given on p. 42.

- Notes on Foods for Beef Products (Food Group 13, p. 62), Pork Products (Food Group 10, p. 104) and Poultry Products (Food Group 05, p. 113) have been updated to include new information. With SR27, Notes on Foods for Lamb, Veal and Game Products (p.85) Have been added.

Data Files

The data files for SR27 are available in ASCII (ISO/IEC 8859-1) format and as a Microsoft Access 2007 database. A description of each field in these files and the relationships between each begins on p. 27. The Access database contains all the SR27 files and relationships, with a few sample queries and reports. An abbreviated file (p. 38) with fewer nutrients (46) but all the food items is also included. A Microsoft Excel 2007 spreadsheet of this file is also provided. These database and spreadsheet files are generally compatible with later releases of the same software package or with other software packages released at the same time.

Database Reports

The data in SR27 are available as page images containing all the data for each food. These data are separated into files by food groups. Adobe Reader is needed to see these files. There is a link from the NDL web site to Adobe's web site where it can be downloaded at no charge. Previously, reports containing selected foods and nutrients sorted either alphabetically or by nutrient content per household measure were available as PDF files. Starting with SR26, these reports are no longer available as the online search (http://ndb.nal.usda.gov) has been upgraded to include the ability to allow users to generate their own custom reports by selecting "Nutrient List" from the list of options. Users can select up to three nutrients from the database and generate reports for either all foods in SR27 or an abridged list (a shorter list of about 1,000 foods adapted from those in our publication: "US Department of Agriculture Home and Garden Bulletin 72, Nutritive Value of Foods" (Gebhardt and Thomas, 2002)). The user can also limit the report to a single food group or several food groups of their choosing. The reports can also be presented per 100 grams or per common household measure. The reports can be saved as either a PDF report or as a comma-delimited text file (csv), which can be opened in Excel or used with other programs.

Database Content

The database consists of several sets of data: food descriptions, nutrients, weights and measures, footnotes, and sources of data. The sections below provide details about the information in each.

Food Descriptions

This file includes descriptive information about the food items. For more details on the format of the Food Description file, see “Food Description File Formats” (p. 29). A full description (containing the name of the food with relevant characteristics, e.g., raw or cooked, enriched, color) and a short description (containing abbreviations) are provided. Abbreviations used in creating short descriptions are given in Appendix A. In creating the short description, the first word in the long description is not abbreviated. In addition, if the long description is 25 characters or less, the short description contains no abbreviations. Abbreviations used elsewhere are given in Appendix B. Brand names used in food descriptions are in upper case. Scientific names, common names, manufacturers’ names, amounts of refuse, and refuse descriptions are provided where appropriate. The common name field includes alternative names for a product, e.g., soda or pop, for a carbonated beverage. In addition this field also includes Uniform Retail Meat Identity Standard (URMIS) identification numbers and USDA commodity codes as appropriate. The food group to which the food item belongs is also indicated. A code is also provided indicating if the item is used in the Food and Nutrient Database for Dietary Studies (FNDDS; USDA, ARS, 2012). The factors used to calculate protein from nitrogen are included, as well as those used to calculate kilocalories. There are no factors for items prepared using the recipe program of the NDBS or for items where the manufacturer calculates protein and kilocalories.

The refuse and refuse description fields contain amounts and descriptions of inedible material (for example, seeds, bone, and skin) for applicable foods. These amounts are expressed as a percentage of the total weight of the item as purchased, and they are used to compute the weight of the edible portion. Refuse data were obtained from NFNAP and other USDA-sponsored contracts and US Department of Agriculture Handbooks 102 (Matthews and Garrison, 1975) and 456 (Adams, 1975). To calculate the “amount of nutrient in edible portion of 1 pound (453.6 grams) as purchased,” use the following formula:

$$Y = V*4.536*[(100-R)/100]$$

where:

Y = nutrient value per 1 pound as purchased,
V = nutrient value per 100 g (Nutr_Val in the Nutrient Data file), and
R = percent refuse (Refuse in the Food Description file).

For meat cuts containing bone and connective tissue, the amount of connective tissue is included in the value given for bone. Separable fat is not shown as refuse if the meat is described as separable lean and fat. Separable fat generally refers to seam fat and external trim fat. Separable lean refers to muscle tissue that can be readily separated from fat, bone, and connective tissue in the intact cut; it includes any fat striations (marbling) within the muscle. For boneless cuts, the refuse value applies to connective tissue or connective tissue plus separable fat. The percentage yield of cooked, edible meat from 1 pound of raw meat with refuse can be determined by using the following formula:

$$Y = (W_c/453.6)*100$$

where:

Y = percentage yield of cooked edible meat per 1 pound as purchased, and
W_c = weight of cooked, edible meat in grams.

Food Group. To facilitate data retrieval the food items in SR are organized into food groups. Currently there are 25 food groups, which are listed in the Food Group Description file. For more details on the format of this file, see “Food Group Data File Formats” (p. 31). Starting with SR25, the food group, “Ethnic Foods” has been renamed “American Indian/Alaska Native Foods” to better reflect its contents. Data on other ethnic foods are contained in their respective food groups, for example data on plantains, a Latino ethnic food are in food group 9 (Fruit and Fruit Juices), while the Asian foods, miso and natto, are entered in food group 16 (Legumes and Legume Products). Food group 36 (Restaurant Foods) contains foods obtained from casual dining, full service restaurants, Latino restaurants, and Chinese restaurants (not Fast Foods, which are in food group 21). Home prepared items or prepared frozen entrees are included in Food Group 22, Meals, Entrees, and Side dishes. Some food items, such as beverages and rice, though obtained at restaurants are included in their respective food groups.

LanguaL. To address the needs of diverse users of the USDA food composition databases, starting with SR23, NDL is providing an expanded standardized food description for selected food groups (spices and herbs, fruits and fruit juices, pork products, vegetables and vegetable products, and beef products) based on the LanguaL Thesaurus (Moeller and Ireland, 2009). The use of this multi-hierarchical food classification system will permit the harmonization of food description terms and definitions across many cultures and languages to support food research, food safety, nutrition monitoring, and food marketing**.**

LanguaL stands for "**Langua aL**imentaria" or "language of food". Work on LanguaL was started in the late 1970's by the Center for Food Safety and Applied Nutrition (CFSAN) of the United States Food and Drug Administration as a co-operative effort of specialists in food technology, information science, and nutrition.

Since then, LanguaL has developed in collaboration with the NCI, and, more recently, its European partners, notably France, Denmark, Switzerland, and Hungary. Since 1996, the European LanguaL Technical Committee has administered the thesaurus.

The thesaurus provides a standardized language for describing foods, specifically for classifying food products for information retrieval. LanguaL is based on the concept that:

- Any food (or food product) can be systematically described by a combination of characteristics or facets;
- These characteristics can be categorized into viewpoints and coded for computer processing; and
- The resulting viewpoint/characteristic codes can be used to retrieve data about the food from external databases.

The current facets for foods in SR27 include: product type; food source; part of plant or animal; physical state, shape or form; extent of heat treatment; cooking method; treatment applied; preservation method; packing medium; container or wrapping; food contact surface; consumer group/dietary use/label claim; geographic places and regions; and adjunct characteristics of food.

The specific tables added to SR are the LanguaL Factor File (p. 31) and the LanguaL Factors Description File (p. 31). For more information on LanguaL, see the web site: http://www.langual.org.

Nutrients

The Nutrient Data file contains mean nutrient values per 100 g of the edible portion of food, along with fields to further describe the mean value. The following statistical attributes are provided to better describe the data:

- Nutrient value—the mean of the data values for a specific parameter. Nutrient values have been rounded to the number of decimal places for each nutrient as specified in the Nutrient Definition file (p. 34).
- Number of data points—the number of data points used to estimate the mean.
- Standard error—the standard error of the mean: a measure of variability of the mean value as a function of the number of data points.
- Number of studies—the number of analytical studies used to generate the mean. A study is a discrete research project conducted or reported for a specific food. A study can be the analysis of one nutrient in one food, one nutrient in many foods, or many nutrients in many foods.
- Minimum value—the smallest observed value in the range of values.
- Maximum value—the largest observed value in the range of values.
- Degrees of freedom—the number of data values that are free to vary after certain restrictions are placed on the estimates; used in probability calculations.

- Lower- and upper-error bounds—represents a range of values within which the population mean is expected to fall, given a pre-specified confidence level. For SR27 and related releases, the confidence level is 95 percent.
- Statistical comments—provide additional details about certain assumptions made during statistical calculations. The definition of each comment is given after the description of the Nutrient Data file under "File Formats" (p. 31).

Other fields provide information on how the values were generated, as follows:

- Source code—contains codes indicating the type of data (e.g., analytical, calculated, assumed zero) in the Nutrient Data file.
- Derivation code—gives more information about how a value was calculated or imputed. Procedures used to impute a nutrient value are described by Schakel *et al*. (1997).
- Reference NDB number—indicates the NDB number of the food item that was used to impute a nutrient value for another food. This field is only populated for items which have been added or updated since SR14 for which an imputed value is provided.
- Added nutrient marker—a "Y" indicates that a mineral or vitamin was added for enrichment or fortification. This field is populated for ready-to-eat breakfast cereals and many brand-name hot cereals in food group 08. In future releases, this field will be populated for other food groups, where applicable.
- AddMod_Date—indicates when a value was either added to the database or last modified. This field was first added with SR24 (2011). Data, which have not been updated since SR14 (2001) carry the date when that section of AH-8 was published. When the nutrient values are reviewed, but not modified, there is no change in the AddMod_Date. Hence, the field may not accurately reflect the currency of the data. Dates associated with calculated values (carbohydrate by difference, energy, vitamin A (IU and RAE), and folate DFE) may carry newer dates reflecting their recalculation when other values in the profile of a particular food item were updated, though the values from which the specific value was calculated may not have changed. Only values added or modified since SR14 will have newer dates. To determine if the date has changed the values between the current and preceding releases are compared to the number of decimal places specified in the Nutr_Def table. The date associated with the source documents used to determine the mean can be found in the Sources of Data file. The description of this file can be found on p. 37.
- Confidence code—indicates the relative quality of the data. This code is derived using the data quality criteria first described by Mangels *et al*. (1993). These criteria have been expanded and enhanced for the NDBS (Holden *et al*., 2002). This field is included as a placeholder for future releases.

For more details on the Nutrient Data file, see "Nutrient Data File Formats" (p. 32). Nutrient values indicate the total amount of the nutrient present in the edible portion of the food, including any nutrients added in processing. Table 1 gives an idea of the

comprehensiveness of the database by listing for each nutrient the number of food items that contain data.

Table 1.—Number of Foods in the Database (*n* = 8618) Containing a Value for the Specified Nutrient

Nutr. No	Nutrient	Count
255	Water *†	8612
208	Energy *†	8618
268	Energy	8584
203	Protein *†	8618
204	Total lipid (fat) *†	8618
207	Ash *†	8286
205	Carbohydrate, by difference *†	8618
291	Fiber, total dietary *†	7962
269	Sugars, total *†	6679
210	Sucrose	1544
211	Glucose (dextrose)	1551
212	Fructose	1550
213	Lactose	1530
214	Maltose	1518
287	Galactose	1396
209	Starch	1041
301	Calcium, Ca *†	8264
303	Iron, Fe *†	8471
304	Magnesium, Mg *†	7936
305	Phosphorus, P *†	8046
306	Potassium, K *†	8208
307	Sodium, Na *†	8535
309	Zinc, Zn *†	7917
312	Copper, Cu *†	7363
315	Manganese, Mn †	6478
317	Selenium, Se *†	6868
313	Fluoride, F	532
401	Vitamin C, total ascorbic acid *†	7826
404	Thiamin *†	7939
405	Riboflavin *†	7961

Nutr. No	Nutrient	Count
406	Niacin *†	7937
410	Pantothenic acid †	6460
415	Vitamin B-6 *†	7677
417	Folate, total *†	7373
431	Folic acid *†	6631
432	Folate, food *†	6863
435	Folate, DFE *†	6612
421	Choline, total *†	4534
454	Betaine	2075
418	Vitamin B-12 *†	7427
578	Vitamin B-12, added *	4668
320	Vitamin A, RAE *†	7089
319	Retinol *†	6806
321	Carotene, beta *†	5356
322	Carotene, alpha *†	5263
334	Cryptoxanthin, beta *†	5252
318	Vitamin A, IU *†	7932
337	Lycopene †	5228
338	Lutein + zeaxanthin *†	5206
323	Vitamin E (alpha-tocopherol) *†	5613
573	Vitamin E, added *	4501
341	Tocopherol, beta	1763
342	Tocopherol, gamma	1760
343	Tocopherol, delta	1744
344	Tocotrienol, alpha	1353
345	Tocotrienol, beta	1367
346	Tocotrienol, gamma	1357
347	Tocotrienol, delta	1354
328	Vitamin D (D2 + D3) *†	5319
325	Vitamin D2 (ergocalciferol)	76
326	Vitamin D3 (cholecalciferol)	1890

Nutr. No	Nutrient	Count
324	Vitamin D †	5320
430	Vitamin K (phylloquinone) *†	4969
429	Dihydrophylloquinone	1348
428	Menaquinone-4	523
606	Fatty acids, total saturated *†	8274
607	4:0 *	5589
608	6:0 *	5621
609	8:0 *	5836
610	10:0 *	6207
611	12:0 *	6460
696	13:0	263
612	14:0 *	6828
652	15:0	2166
613	16:0 *	7037
653	17:0	2552
614	18:0 *	7027
615	20:0	2628
624	22:0	2101
654	24:0	2016
645	Fatty acids, total monounsaturated *†	7947
625	14:1	2520
697	15:1	1871
626	16:1 undifferentiated *	6799
673	16:1 c	1201
662	16:1 t	1073
687	17:1	2247
617	18:1 undifferentiated *	7053
674	18:1 c	1668
663	18:1 t	1717
859	18:1-11 t (18:1t n-7)	152
628	20:1	6213
630	22:1 undifferentiated *	5676
676	22:1 c	984
664	22:1 t	717
671	24:1 c	1206

Nutr. No	Nutrient	Count
646	Fatty acids, total polyunsaturated *†	7954
618	18:2 undifferentiated *	7070
675	18:2 n-6 c,c	1629
670	18:2 CLAs	1296
669	18:2 t,t	353
666	18:2 i	60
665	18:2 t not further defined	1003
619	18:3 undifferentiated *	6972
851	18:3 n-3 c,c,c (ALA)	1772
685	18:3 n-6 c,c,c	1482
856	18:3i	378
627	18:4	5603
672	20:2 n-6 c,c	2283
689	20:3 undifferentiated	2084
852	20:3 n-3	872
853	20:3 n-6	1073
620	20:4 undifferentiated *	6222
855	20:4 n-6	162
629	20:5 n-3 (EPA) *	5693
857	21:5	117
858	22:4	890
631	22:5 n-3 (DPA) *	5649
621	22:6 n-3 (DHA) *	5651
605	Fatty acids, total trans	3243
693	Fatty acids, total trans-monoenoic	1696
695	Fatty acids, total trans-polyenoic	1400
601	Cholesterol *†	8250
636	Phytosterols	499
638	Stigmasterol	132
639	Campesterol	131
641	Beta-sitosterol	132
501	Tryptophan	5129
502	Threonine	5175

Nutr. No	Nutrient	Count
503	Isoleucine	5179
504	Leucine	5178
505	Lysine	5192
506	Methionine	5191
507	Cystine	5026
508	Phenylalanine	5175
509	Tyrosine	5145
510	Valine	5179
511	Arginine	5165
512	Histidine	5172
513	Alanine	5121
514	Aspartic acid	4966
515	Glutamic acid	5124
516	Glycine	5121
517	Proline	5112
518	Serine	5121
521	Hydroxyproline	1393
221	Alcohol, ethyl *	5345
262	Caffeine *	5143
263	Theobromine*	5103

*Indicates the 65 nutrients included in the USDA Food and Nutrient Database for Dietary Studies (FNDDS).
† Nutrients included in the Abbreviated file (p. 38).

In general, levels of fortified nutrients are the values calculated by the manufacturer or by NDL, based on the Nutrition Labeling and Education Act (NLEA) label declaration of % Daily Value (DV) (CFR, Title 21, Pt. 101) (US Food and Drug Administration–Department of Health and Human Services, 2012). Such values represent the minimum nutrient level expected in the product. If analytical values were used to estimate levels of added nutrients, a number is present in the sample count field for these nutrients.

***Nutrient Retention and Food Yield*.** When nutrient data for prepared or cooked products are unavailable or incomplete, nutrient values are calculated from comparable raw items or by recipe. When values are calculated in a recipe or from the raw item, appropriate nutrient retention (USDA, 2007) and food yield factors (Matthews and Garrison, 1975) are applied to reflect the effects of food preparation on food weights and nutrient content. To obtain the content of nutrient per 100 g of cooked food, the nutrient content per 100 g of raw food is multiplied by the nutrient retention factor and, where appropriate, adjustments are made for fat and moisture gains and losses.

Nutrient retention factors are based on data from USDA research contracts, research reported in the literature, and USDA publications. Most retention factors were calculated by the True Retention Method (%TR) (Murphy *et al*., 1975). This method, as shown below, accounts for the loss or gain of moisture and the loss of nutrients due to heat or other food preparation methods:

$$\%TR = (N_c * G_c) / (N_r * G_r) * 100$$

where:

TR = true retention
N_c = nutrient content per g of cooked food,
G_c = g of cooked food,
N_r = nutrient content per g of raw food, and
G_r = g of food before cooking.

***Proximates*.** The term proximate component refers to those macronutrients that include water (moisture), protein, total lipid (fat), total carbohydrate, and ash. Except in the case of a few foods, nutrient profiles have values for the proximate components and at least one other nutrient.

Protein. The values for protein were calculated from the amount of total nitrogen (N) in the food, using the specific conversion factors recommended by Jones (1941) for most food items. The analytical methods used to determine the nitrogen content of foods are AOAC 968.06 (4.2.04), 992.15 (39.1.16) and 990.03 (combustion) and 991.20 (Kjeldahl) (AOAC, 2010). The specific factor applied to each food item is provided in the N_Factor field in the Food Description file. The general factor of 6.25 is used to calculate protein in items that do not have a specific factor. When the protein content of a multi-ingredient food (e.g., beef stew) is calculated using the recipe program of the NDBS the specific nitrogen to protein conversion factors are applied at the ingredient level. Therefore, the N-factor field will remain empty. When the manufacturer calculates protein the N-factor field will also be empty.

Protein values for chocolate, cocoa, coffee, mushrooms, and yeast were adjusted for non-protein nitrogenous material (Merrill and Watt, 1973). The adjusted protein conversion factors used to calculate protein for these items are as follows:

chocolate and cocoa	4.74
coffee	5.3
mushrooms	4.38
yeast	5.7

When these items are used as ingredients, such as chocolate in chocolate milk or yeast in bread, only their protein nitrogen content was used to determine their contribution to the calculated protein and amino acid content of the food. Protein calculated from total nitrogen, which may contain non-protein nitrogen, was used in determining carbohydrate by difference. This unadjusted protein value is not given in the Nutrient Data file for SR27; rather, it was previously included as a footnote in printed sections of "Agriculture Handbook 8."

For soybeans, nitrogen values were multiplied by a factor of 5.71 (Jones, 1941) to calculate protein. The soybean industry, however, uses 6.25 to calculate protein. To convert these values divide the proteins value by 5.71, and then multiply the resulting value by 6.25. It will also be necessary to adjust the value for carbohydrate by difference (Nutr. No. 205).

Total Lipid. The total lipid (fat) content of most foods obtained through NFNAP is determined by gravimetric methods, including acid hydrolysis (AOAC 922.06, 925.12, 989.05, or 954.02) and extraction methods using a mixed solvent system of chloroform and methanol (AOAC 983.25 or Folch *et al*. 1957). Older values may have been obtained by ether extraction (AOAC 920.39, 933.05, or 960.39). Total lipid determined by extraction is reported as Nutrient No. 204. It is sometimes referred to as "crude fat" and includes the weight of all lipid components, including glycerol, soluble in the solvent system. Nutrient No. 204 may not be identical to the fat level declared on food labels under the NLEA, where fat is expressed as the amount of triglyceride that would produce the analytically determined amount of lipid fatty acids and does not include other lipid components not soluble in the solvent system. The term "NLEA fat" is commonly referred to as "total fatty acids expressed as triglycerides."

Ash. The ash content of foods is determined by gravimeteric methods (AOAC 923.03, 942.05, or 945.46).

Moisture. The moisture (or water) content of foods is determined by vacuum oven (AOAC 934.01, 934.06, 964.22) or forced air (AOAC 950.46).

Carbohydrate. Carbohydrate, when present, is determined as the difference between 100 and the sum of the percentages of water, protein, total lipid (fat), ash, and, when present, alcohol. Total carbohydrate values include total dietary fiber. Available carbohydrate, which is used in some countries, can be calculated if desired by the user, by subtracting the sum of the percentages of water, protein, total lipid (fat), ash, total dietary fiber, and alcohol (when present) from 100. Carbohydrate in beer and wine is determined by methods 979.06 (27.1.21) and 985.10 (28.1.18) of AOAC International (AOAC, 2010), respectively. Total dietary fiber content is determined by enzymatic-gravimetric methods 985.29 or 991.43 of the AOAC (2010). Total sugars is the term used for the sum of the individual monosaccharides (galactose, glucose, and fructose) and disaccharides (sucrose, lactose, and maltose). Analytical data for individual sugars obtained through NFNAP were determined by liquid chromatography (AOAC 982.14). Earlier values were also determined using AOAC methods (2010), with either high-performance liquid chromatography (HPLC) or gas-liquid chromatography (GLC). When analytical data for total sugars are unavailable for items in the FNDDS, values are imputed or obtained from manufacturers and trade associations. Starch is analyzed using the AOAC method 966.11 (2010) or by a polarometric method (The Feedings Stuffs Regulations 1982). Because the analyses of total dietary fiber, total sugars, and starch are performed separately and reflect the analytical variability inherent to the measurement process, the sum of these carbohydrate fractions may not equal the carbohydrate-by-difference value.

Food Energy. Food energy is expressed in kilocalories (kcal) and kilojoules (kJ). One kcal equals 4.184 kJ. The data represent physiologically available energy, which is the energy value remaining after digestive and urinary losses are deducted from gross energy. Energy values, with the exception of multi-ingredient processed foods, are

based on the Atwater system for determining energy values. Derivation of the Atwater calorie factors is discussed in “Agriculture Handbook 74” (Merrill and Watt, 1973). For multi-ingredient processed foods (source codes 8 or 9; for more information on source codes, see p. 34) kilocalorie values generally reflect industry practices (as permitted by NLEA) of calculating kilocalories as 4, 4, or 9 kilocalories per gram of protein, carbohydrate, and fat, respectively, or as 4, 4, or 9 kilocalories per gram of protein, carbohydrate minus insoluble fiber, and fat. The latter method is often used for high-fiber foods.

Calorie factors for protein, fat, and carbohydrates are included in the Food Description file. For foods containing alcohol, a factor of 6.93 is used to calculate kilocalories per gram of alcohol (Merrill and Watt, 1973). No calorie factors are given for items prepared using the recipe program of the NDBS. Instead, total kilocalories for these items equal the sums of the kilocalories contributed by each ingredient after adjustment for changes in yield, as appropriate. For multi-ingredient processed foods, if the kilocalories calculated by the manufacturer are reported, no calorie factors are given.

Calorie factors for fructose and sorbitol, not available in the Atwater system, are derived from the work of Livesay and Marinos (1988). Calorie factors for coffee and tea are estimated from those for seeds and vegetables, respectively.

Minerals. Minerals included in the database are calcium, iron, magnesium, phosphorus, potassium, sodium, zinc, copper, manganese, selenium, and fluoride. Levels of minerals for most foods are determined by methods of the AOAC (2010). Calcium, iron, magnesium, phosphorus, sodium, potassium, zinc, copper, and manganese are usually determined by inductively coupled plasma emission spectrophotometry (AOAC 984.27) or, except for phosphorus, by atomic absorption (AOAC 985.35), with phosphorus determined colorimetrically by AOAC 2.019, 2.095 and 7.098.

Analytical data for selenium were published earlier by USDA (1992) and were determined by the modified selenium hydride and fluorometric methods. Selenium values for foods analyzed between 1998 and 2008 for NFNAP are determined by either the modified selenium hydride (AOAC 986.15) or stable isotope dilution gas chromatography-mass spectrometry (Reamer and Veillon, 1981) methods. The selenium content of plants, in particular cereal grains, is strongly influenced by the quantity of biologically available selenium in the soil in which the plants grow, that is, by their geographical origin (Kubota and Allaway, 1972). The values given are national averages and should be used with caution when levels of selenium in locally grown foods are of interest or concern.

Beginning with SR19 (2006), values for fluoride, previously released in the USDA National Fluoride Database of Selected Beverages and Foods, Release 2 (USDA, 2005), are included in SR. Other analyzed values in the Fluoride Database, including regional values, are not included in SR. Samples are analyzed using a fluoride ion-specific electrode, direct read method (VanWinkle, 1995) for clear liquids and a micro-diffusion method (VanWinkle, 1995) for other food samples. As with selenium, the

values for fluoride are national averages and should be used with caution when levels of fluoride in locally produced foods and beverages are of interest or concern.

***Vitamins*.** Vitamins included in the database are ascorbic acid (vitamin C), thiamin, riboflavin, niacin, pantothenic acid, vitamin B_6, vitamin B_{12}, added vitamin B_{12}, folate, total choline, betaine, vitamin A (individual carotenoids, and retinol), vitamin E (tocopherols and tocotrienols), added vitamin E, vitamin K (phylloquinone, dihydrophylloquinone and menaquinone-4), and vitamin D (D_2 and D_3).

Ascorbic acid. In the current database system, nearly all data for ascorbic acid listed under Nutrient No. 401, total ascorbic acid, have been determined by the microfluorometric method (AOAC 967.22). Older values which have not been updated are primarily for reduced ascorbic acid and were determined by the dichloroindophenol method (AOAC 967.21).

Thiamin, Riboflavin, and Niacin. Thiamin is determined chemically by the fluorometric method (AOAC 942.23). Fluorometric (AOAC 970.65) or microbiological (AOAC 940.33) methods are used to measure riboflavin. Niacin is determined by microbiological methods (AOAC 944.13). The values for niacin are for preformed niacin only and do not include the niacin contributed by tryptophan, a niacin precursor. The term “niacin equivalent” applies to the potential niacin value; that is, to the sum of the preformed niacin and the amount that could be derived from tryptophan (the mean value of 60 mg tryptophan is considered equivalent to 1 mg niacin (IOM, 1998)). Although not included in SR, niacin equivalents can be estimated for those foods where amino acids are given:

mg Niacin equivalents = mg niacin + (mg tryptophan / 60).

Pantothenic acid, Vitamins B_6, and B_{12}. Pantothenic acid (AOAC 945.74 or 992.07), vitamin B_6 (AOAC 961.15), and vitamin B_{12} (AOAC 952.20) are determined by microbiological methods. Vitamin B_{12} is found intrinsically in foods of animal origin or those containing some ingredient of animal origin, e.g., cake that contains eggs or milk. For foods that contain only plant products, the value for vitamin B_{12} is assumed to be zero with the exception of some fortified foods discussed below. Some reports contain values for vitamin B_{12} in certain fermented foods (soy sauce and miso). It is believed that this B_{12} is synthesized not by the microorganisms responsible for the fermentation of the food, but rather by other contaminating microorganisms. Therefore, one should not consider these foods to be a consistent source of vitamin B_{12} (Liem *et al*., 1977) and these values are not included in the database.

The Dietary Reference Intakes (DRI) report on vitamin B_{12} recommended that people older than 50 years meet their Recommended Dietary Allowances (RDA) mainly by consuming foods fortified with vitamin B_{12} or a vitamin B_{12}-containing supplement (IOM, 1998). Since vitamin B_{12} added as a fortificant may provide a significant source of the vitamin in the diet, Nutrient No. 578 for “added vitamin B_{12}” has been added to the database. In this release, there are over 300 foods fortified with vitamin B_{12}. The vast

majority are breakfast cereals, infant formulas, and plant-based meat substitutes. For these foods, the value for total vitamin B_{12} is used for "added vitamin B_{12}." Only a few cereals containing a milk ingredient would contain any intrinsic vitamin B_{12}. Milk-based infant formulas should contain intrinsic vitamin B_{12}. Plant-based meat substitutes should not contain intrinsic vitamin B_{12}.

Folate. Values are reported for folic acid (Nutr. No. 431), food folate (Nutr. No. 432), and total folate reported in µg (Nutr. No. 417) and as dietary folate equivalents (DFEs) (Nutr. No. 435). These varied folate forms are included and defined as described in the DRI report on folate (IOM, 1998). RDAs for folate are expressed in DFEs, which take into account the greater bioavailability of synthetic folic acid compared with naturally occurring food folate.

To calculate DFEs for any single food, it is necessary to have separate values for naturally occurring food folate and added synthetic folic acid in that item.

µg DFE = µg food folate + (1.7 * µg folic acid)

Folate values for foods analyzed through NFNAP are generated using the trienzyme microbiological procedure (Martin *et al*., 1990). For a small number of foods, total folate was determined as the sum of one or more individual folate vitamers (5-methyltetrahydrofolate, 10-formyl folic acid, 5-formyltetrahydrofolic acid, and tetrahydrofolic acid); these are indicated in the footnotes. Microbiological methods measure µg total folate; for enriched foods, folic acid and food folate are not distinguished from each other. Therefore, to be able to calculate DFE, multi-ingredient enriched foods are analyzed by an additional microbiological procedure without enzymes to estimate the amount of added folic acid (Chun *et al*., 2006). Food folate is then calculated by difference.

The addition of folic acid to enriched cereal-grain products subject to standards of identity began in the United States on January 1, 1998 (CFR, Title 21, Pts. 136—137). These products include enriched flour, cornmeal and grits, farina, rice, macaroni, noodles, bread, rolls, and buns. Folic acid may continue to be added (with some restrictions on amounts) to breakfast cereals, infant formulas, medical foods, food for special dietary use, and meal replacement products.

For unenriched foods, food folate would be equivalent to total folate since folic acid (pteroylmonoglutamic acid) occurs rarely in foods. Therefore, the same value with its number of data points and standard error, if present, is used for total folate and food folate. The folic acid value is assumed to be zero.

For enriched cereal-grain products with standards of identity (flour, cornmeal and grits, farina, rice, macaroni, noodles, bread, rolls, and buns), the folic acid value is calculated by subtracting the analytical folate value before fortification from the analytical value for the fortified product.

Some ready-to-eat (RTE) cereals have been fortified with folic acid for over 25 years, and food folate values (before fortification) are not readily available for these products. Food folate was estimated by means of the NDBS formulation program for a variety of high-consumption cereals. Mean folate values were calculated for categories of RTE cereals based on grain content. Added folic acid was then calculated by subtracting estimated food folate from the total folate content. Generally, food folate values represent a small proportion of the total folate in the fortified products.

Choline and Betaine. Beginning with SR19 (2006), total choline and betaine values from the USDA Database for the Choline Content of Common Foods, Release 2 (USDA, 2008) have been incorporated into SR. In some cases, newer values have been incorporated into SR and these supersede the values in the Special Interest Database for choline. Values for the individual metabolites have not been added to SR, but are available in the USDA Database for the Choline Content of Common Foods, (http://www.ars.usda.gov/Services/docs.htm?docid=6232).

For analysis, choline compounds are extracted, partitioned into organic and aqueous phases using methanol and chloroform, and analyzed directly by liquid chromatography-electrospray ionization-isotope dilution mass spectrometry (LC-ESI-IDMS) (Koc *et al*., 2002). Samples are analyzed for betaine and these choline-contributing compounds: free choline (Cho), glycerophosphocholine (GPC), phosphocholine (Pcho), phosphatidylcholine (Ptdcho), and sphingomyelin (SM).

Because there are metabolic pathways for the interconversion of Cho, GPC, Pcho, PtdCho, and SM (Zeisel *et al*., 1994), total choline content is calculated as the sum of these choline-contributing metabolites. Betaine values are not included in the calculation of total choline since the conversion of choline to betaine is irreversible (Zeisel *et al*., 2003).

Vitamin A. Beginning with SR15 (2002), values for vitamin A in µg of retinol activity equivalents (RAEs) and µg of retinol are reported. At the same time, values in µg of retinol equivalents (REs) were dropped from the database.

This change responded to new reference values for vitamin A in the DRI report issued by the Institute of Medicine of the National Academies (IOM, 2001). The report recommended changing the factors used for calculating vitamin A activity from the individual provitamin A carotenoids and introduced RAE as a new unit for expressing vitamin A activity. One µg RAE is equivalent to 1 µg of all-*trans*-retinol, 12 µg of all-*trans*-β-carotene, or 24 µg of other provitamin A carotenoids. The RAE conversion factors are based on studies showing that the conversion of provitamin A carotenoids to retinol was only half as great as previously thought.

Vitamin A is also reported in international units (IU), and will continue to be reported because it is still the unit used for nutrition labeling in the US. One IU is equivalent to 0.3 µg retinol, 0.6 µg β-carotene, or 1.2 µg other provitamin-A carotenoids (NAS/NRC, 1989) and thus over-estimates bioavailability.

Individual carotenoids (β-carotene, α-carotene, β-cryptoxanthin, lycopene, and lutein+zeaxanthin) are reported. The analytical data are from NFNAP, generated using HPLC methodology (AOAC 941.15 or Craft, 2001). Most analytical systems do not separate lutein and zeaxanthin, so these carotenoids are shown combined. These values supersede those in Holden *et al*., 1999. Vitamin A activity values in RAE and IU were calculated from the content of retinol and individual carotenoids (β-carotene, α-carotene, and β-cryptoxanthin) using the appropriate factors. For food items used in the FNDDS, carotenoid values are imputed if analytical data are not available. For many of these items data are only available for vitamin A in IU. The variability in carotenoid levels due to cultivar, season, growing area, etc., as well as rounding within the NDBS, increases the difficulty in matching the calculated vitamin A activity values from imputed individual carotenoids to the existing IU values. As a result, the vitamin A IU value agrees within ±15 IU of the value calculated from individual carotenoids.

When individual carotenoids are not reported for plant foods (i.e., fruits, vegetables, legumes, nuts, cereal grains, and spices and herbs), µg RAE are calculated by dividing the IU value by 20. In foods of animal origin, such as eggs, beef, pork, poultry, lamb, veal, game, and fish (except for some organ meats and dairy), all of the vitamin A activity is contributed by retinol. For these foods, where analytical data are not available, µg RAE and µg of retinol are calculated by dividing the IU value by 3.33.

In foods that contain both retinol and provitamin A carotenoids, the amount of each of these components must be known to calculate RAE. Previously, most of the vitamin A data in the database were received as IU. Therefore, the amounts of the provitamin A carotenoids and retinol were then estimated from the ingredients. Once the components had been estimated, µg RAE were calculated as (IU from carotenoids/20) + (IU from retinol/3.33). Micrograms of retinol were calculated as IU from retinol/3.33.

Vitamin D. Due to considerable public health interest in vitamin D, a multi-year project was undertaken by NDL to expand and update the relatively small existing dataset of vitamin D values in SR. Much of the original data for vitamin D had been published earlier in USDA's Provisional Table (PT-108) (Weihrauch and Tamaki, 1991), with values for fortified foods updated as needed with data received from the food industry. Earlier data collected between 1999 and 2008 utilized AOAC methods 982.29 or 992.26.

The availability of vitamin D data for foods permitting subsequent dietary intake assessment is expected be a useful tool in investigating dietary requirements of vitamin D in vulnerable groups, one of the specific research recommendations of the 2005 Dietary Guidelines Committee (DGAC. 2004). An Institute of Medicine Committee to Review Dietary Reference Intakes for Vitamin D and Calcium was convened in 2009 to assess current relevant data and revise, as appropriate, the DRIs for vitamin D and calcium. Their report was issued in 2011 (IOM).

Cholecalciferol (vitamin D_3; Nutr. No. 326) is the form naturally occurring in animal products and the form most commonly added to fortified foods. Ergocalciferol (vitamin D_2; Nutr. No. 325) is the form found in plants and is added to some fortified foods, such as soy milk. In SR27, vitamin D (Nutr. No. 328) is defined as the sum of vitamin D_2 and vitamin D_3.

Before foods could be analyzed for vitamin D and included in SR, analytical methodology had to be developed that could be used for a variety of food matrices (Byrdwell, 2008). Although a single method is not required for USDA-sponsored analyses, all participating laboratories must demonstrate that their analysis of quality control materials falls within an acceptable range of values. For vitamin D, all methods involved extraction with solvent(s), cleanup steps, and quantification by HPLC or by HPLC and LC/MS. In the absence of certified quality control materials for vitamin D, NDL, in collaboration with Virginia Tech, developed five matrix-specific materials, one of which was sent with every batch of foods to be analyzed. The materials were: vitamin D_3 fortified fluid milk, a vitamin D_3 fortified multigrain ready-to-eat cereal, orange juice fortified with calcium and vitamin D_3, pasteurized process cheese fortified with vitamin D_3, and canned red salmon, a natural source of D_3 (Phillips *et al*., 2008). Vitamin D may also be present as 25-hydroxycholecalciferol in some foods such as fish, meat, and poultry. At this point the analytical methodology used to determine this metabolite of vitamin D has not been sufficiently validated; when work on this validation is completed 25-hydroxycholecalciferol values will be provided in future releases of SR.

Once an improved method of analysis was developed (Byrdwell, 2008), and the laboratories certified, a selection of foods, representing natural vitamin D sources and fortified sources, were chosen for sampling and analysis under the NFNAP (Haytowitz *et al*., 2008). Analyses have been completed for raw eggs and the following fortified products: fluid milk at 4 fat levels, reduced fat chocolate milk, fruit yogurt, and orange juice. Current analytical values for fish are based on limited analyses; additional samples are being analyzed and values will be updated in future SR releases. Vitamin D analyses have also been completed for selected cuts/pieces of chicken, pork, and beef. These data have been determined by a new LC/MS/MS method (Huang and Winters, 2011).

Vitamin D values in SR27 are provided in both micrograms (µg) and International Units (IU) to support both the analytical unit (µg) and the unit (IU) that is currently used in nutrient labeling of foods in the US. The biological activity of vitamin D is given as 40 IU/µg. Where available, specific isomers of vitamin D are reported only in µg. Calculations for vitamin D in SR include:

Vitamin D, µg (Nutr. No. 328) = vitamin D_2, µg + vitamin D_3, µg
Vitamin D, IU (Nutr. No. 324) = vitamin D, µg x 40

Vitamin D values in µg (Nutr. No. 328) are provided for all items in SR27 used to create the FNDDS.

In some cases, it was possible to identify food groups for which the foods do not provide or only contain trace amounts of vitamin D. Values for those foods were set to zero. For example, except for mushrooms, plant foods are not expected to contain any appreciable levels of vitamin D. In order to provide vitamin D estimates for the rest of the foods provided to create the FNDDS, data for other foods have been taken from the scientific literature or from other food composition databases, calculated from industry-declared % DV fortification levels, determined by formulation/recipe techniques, or estimated by other USDA imputation methods.

Fluid milk available at the retail level is fortified. The dairy industry provided guidance that most dairy products used as ingredients in formulated (commercial multi-ingredient) foods, are not likely to be fortified with vitamin D. Likewise, margarine used in commercial products is generally not vitamin D-fortified; a relatively low number of vitamin D-fortified margarines and spreads are available in the retail market. For ingredients that could be fortified at the retail level, but generally are not fortified at the food processing level, two related profiles are available in SR – one with added vitamin D and one without. When estimates were calculated for formulated foods, the unfortified profile was used. For home-prepared foods, such as pudding prepared with milk, the fortified ingredient(s) was selected for use in the recipe calculation of vitamin D. In the case of margarine, a market-share blend of fortified and unfortified product was used.

For some retail products, such as yogurt, there is considerable brand-to-brand difference in vitamin D fortification practices. One brand or line of products may be fortified with vitamin D, whereas another brand may not. Both types are included in the database. The market changes quickly and consumers concerned about vitamin D intake should always confirm vitamin D content by checking the product label.

Vitamin E. The DRI report (IOM, 2000) defines vitamin E as the naturally occurring form (*RRR*-α-tocopherol) and three synthetic forms of α-tocopherol. Since the release of SR16-1 (2003), NDL has reported vitamin E as mg of α-tocopherol (Nutr. No. 323) in accordance with the DRI report. Analytical values for tocopherols found in the database are determined by gas-liquid chromatography (GLC) or high-performance liquid chromatography (HPLC; Ye *et al*., 2000). Although β, γ, and δ-tocopherol do not contribute to vitamin E activity, they are included in the database when analytical data are available and starting with SR27 (2013) data on α-, β, γ, and δ-tocotrienol have also been included.

In the 2000 DRI report, a revised factor was recommended for calculation of the milligram amounts of α-tocopherol contributed by synthetic forms of vitamin E, since *all rac*-α-tocopherol contains 2*R*-stereoisomeric and 2*S*-stereoisomeric forms in equal amounts. Vitamin E activity to establish recommended intakes is limited to the 2*R*-stereoisomeric forms of α-tocopherol (IOM, 2000).

However, the unit for vitamin E required by the NLEA is IU and is based on the 1968 RDA definitions for vitamin E (CFR, Title 21, Pt. 101) (US Food and Drug Administration–Department of Health and Human Services, 2004).

When NDL receives vitamin E data from the food industry expressed as IU, the values are converted to mg amounts based on the conversions of vitamin E in IU to mg as defined by the DRI report:

One mg of α-tocopherol = IU of the *all rac*-α-tocopherol compound × 0.45; and
One mg of α-tocopherol = IU of the *RRR*-α-tocopherol compound × 0.67.

The basis of the vitamin E tolerable upper intake level (UL), another important reference value defined in the DRI report, was established using all forms of supplemental α-tocopherol (IOM, 2000). Although the 2*S*-stereoisomers do not contribute to dietary requirements for vitamin E (IOM, 2000), they do contribute to the total intake relative to the UL. Starting with SR18 (2005), "added vitamin E" (Nutr. No. 573) was added to the database. In this release, there are about 140 food items that have values for added vitamin E greater than 0. For the majority of these food items, the form added is *all rac*-α-tocopherol; these values should be multiplied by 2 to relate intakes of this form to the UL. Items that are fortified with *RRR*-α-tocopherol are identified by a footnote and the added vitamin E value can be used directly to estimate its contribution to the UL.

Vitamin K. Much of the data for vitamin K has been generated under NFNAP and supersedes the values in the USDA Provisional Table (PT-104) (Weihrauch and Chatra, 1994). Vitamin K is extracted with hexane, purified with solid phase extraction using silica columns, and quantitated using HPLC with chemical reduction and fluorescence detection. Losses are corrected using vitamin $K_{1(25)}$ as the internal standard (Booth *et al*., 1994). Starting with SR23 (2010), in addition to data on vitamin K_1 (Nutr. No. 430), data on dihydrophylloquinone (Nutr. No. 429) and menaquinone-4 (Nutr. No. 428) are also released. Dihydrophylloquinone is created during the commercial hydrogenation of plant oils. Menaquinone-4 is formed from vitamin K_1 and/or the synthetic form of vitamin K found in animal feed, and is found primarily in meats and meat products.

***Lipid Components*.** Fatty acids are expressed as the actual quantity of fatty acid in g per 100 g of food and do not represent fatty acids as triglycerides. Historically, most fatty acid data were obtained as the percentage of fatty acid methyl esters and determined by GLC analyses (AOAC 996.06). These data were converted to g fatty acid per 100 g total lipid using lipid conversion factors and then to g fatty acid per 100 g edible portion of food using the total lipid content. Details of the derivation of lipid conversion factors were published by Weihrauch *et al*., (1977).

In the redesigned NDBS, fatty acid data may be imported in a variety of units and converted within the system. No conversions are required if data are received as g fatty acid per 100 g edible portion of food. Data received as fatty acid esters and as triglycerides are converted to fatty acids using Sheppard conversion factors. Sheppard

conversion factors are based on the molecular weights of the specific fatty acid and its corresponding esters (butyl or methyl) and triglyceride (Sheppard, 1992). When fatty acid data are received as percentages of fatty acid methyl esters, methyl esters are converted to fatty acids using Sheppard conversion factors and then multiplied by total lipid (Nutrient No. 204) to give g fatty acid per 100 g edible portion of food. Occasionally, total lipid values are available from a variety of data sources, but individual fatty acids are available from fewer sources. In those cases, it may be necessary to normalize the individual fatty acids to the mean fat value of the food item. In the case of normalized fatty acids, the sum of the individual fatty acids will equal the mean fat value multiplied by the Weihrauch (1977) lipid conversion factor for that food item. No statistics of variability are reported for normalized fatty acids.

Individual Fatty Acids. The basic format for describing individual fatty acids is that the number before the colon indicates the number of carbon atoms in the fatty acid chain and the number after the colon indicates the number of double bonds. For unsaturated fatty acids, additional nutrient numbers have been added to accommodate the reporting of many specific positional and geometric isomers. Of the specific isomers, there are two basic classifications considered: omega double bond position and *cis/trans* configuration of double bonds.

Omega-3 (n-3) and omega-6 (n-6) isomers are denoted in shorthand nomenclature as n-3 and n-6. The n- number indicates the position of the first double bond from the methyl end of the carbon chain. The letter *c* or *t* indicates whether the bond is *cis* or *trans*. For polyunsaturated fatty acids, *cis* and *trans* configurations at successive double bonds may be indicated. For example, linoleic acid is an 18 carbon omega-6 fatty acid with 2 double bonds, both in *cis* configuration. When data are isomer specific, linoleic acid is described as 18:2 n-6 *c,c.* Other isomers of 18:2, for which nutrient numbers have now been assigned, include 18:2 *c,t*; 18:2 *t,c*; 18:2 *t,t;* 18:2 *t* not further defined; and 18:2 *i.* 18:2 *i* is not a single isomer but includes isomers other than 18:2 n-6 *c,c* with peaks that cannot be easily differentiated in the particular food item. Systematic and common names for fatty acids are given in Table 2.

Table 2 is provided for the convenience of users in attaching common names or systematic names to fatty acids in this database. Though individual fatty acids are more specific than in past releases, it is not possible to include every possible geometric and positional isomer. Where specific isomers exist for a fatty acid, the common name of the most typical isomer is listed for the undifferentiated fatty acid and an asterisk (*) designates the specific isomer to which that name applies. For example, the most typical isomer for 18:1 is oleic acid. Thus, undifferentiated 18:1 is designated in Table 2 as oleic acid, but an asterisk by 18:1 c indicates the common name for 18:1 oleic acid actually only applies to this isomer.

Table 2.—Systematic and Common Names for Fatty Acids

Fatty acid	Systematic name	Common name of most typical isomer	Nutrient number
Saturated fatty acids			
4:0	butanoic	butyric	607
6:0	hexanoic	caproic	608
8:0	octanoic	caprylic	609
10:0	decanoic	capric	610
12:0	dodecanoic	lauric	611
13:0	tridecanoic		696
14:0	tetradecanoic	myristic	612
15:0	pentadecanoic		652
16:0	hexadecanoic	palmitic	613
17:0	heptadecanoic	margaric	653
18:0	octadecanoic	stearic	614
20:0	eicosanoic	arachidic	615
22:0	docosanoic	behenic	624
24:0	tetracosanoic	lignoceric	654
Monounsaturated fatty acids			
14:1	tetradecenoic	myristoleic	625
15:1	pentadecenoic		697
16:1 undifferentiated	hexadecenoic	palmitoleic	626
16:1 *cis*			673*
16:1 *trans*			662
17:1	heptadecenoic		687
18:1 undifferentiated	octadecenoic	oleic	617
18:1 *cis*			674*
18:1 *trans*			663
20:1	eicosenoic	gadoleic	628
22:1 undifferentiated	docosenoic	erucic	630
22:1 *cis*			676*
22:1 *trans*			664
24:1 *cis*	cis-tetracosenoic	nervonic	671
Polyunsaturated fatty acids			
18:2 undifferentiated	octadecadienoic	linoleic	618
18:2 *trans* not further defined			665
18:2 *i* (mixed isomers)			666
18:2 n-6 *cis, cis*			675*
18:2 *trans, trans*			669
18:2 conjugated linoleic acid (CLAs)			670
18:3 undifferentiated	octadecatrienoic	linolenic	619
18:3 n-3 *cis, cis, cis*		alpha-linolenic	851*
18:3 n-6 *cis, cis, cis*		gamma-linolenic	685

Fatty acid	Systematic name	Common name of most typical isomer	Nutrient number
18:3 *trans* (other isomers)			856
18:3 *i* (mixed isomers)			866
18:4	octadecatetraenoic	parinaric	627
20:2 n-6 *cis, cis*	eicosadienoic		672
20:3 undifferentiated	eicosatrienoic		689
20:3 n-3			852
20:3 n-6			853
20:4 undifferentiated			620
20:4 n-6	eicosatetraenoic	arachidonic	855*
20:5 n-3	eicosapentaenoic (EPA)	timnodonic	629
21:5			857
22:4			858
22:5 n-3	docosapentaenoic (DPA)	clupanodonic	631
22:6 n-3	docosahexaenoic (DHA)		621

* Designates the specific isomer associated with the common name; the typical isomer is listed for the undifferentiated fatty acid.

Fatty acid totals. Only a small portion of the fatty acid data received for release in SR27 contains specific positional and geometric isomers. Therefore, it has been necessary to maintain the usual nutrient numbers corresponding to fatty acids with no further differentiation other than carbon length and number of double bonds. To aid users of our data, specific isomers are always summed to provide a total value for the undifferentiated fatty acid. For example, mean values for the specific isomers of 18:2 are summed to provide a mean for 18:2 undifferentiated (Nutrient No. 618). Other fatty acid totals provided are: (1) the sum of saturated, monounsaturated, and polyunsaturated fatty acids; and (2) the sum of *trans*-monoenoic, the sum of *trans*-polyenoic, and the sum of all *trans* fatty acids.

Values for total saturated, monounsaturated, and polyunsaturated fatty acids may include individual fatty acids not reported; therefore, the sum of their values may exceed the sum of the individual fatty acids. In rare cases, the sum of the individual fatty acids may exceed the sum of the values given for the total saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA). These differences are generally caused by rounding and should be relatively small.

For multi-ingredient processed brand-name foods, industry data are often available for fatty acid classes (SFA, MUFA, and PUFA) but are lacking for individual fatty acids. In these cases, individual fatty acids are calculated from the fatty acids of the individually listed ingredients and normalized to the total fat level. A best-fit approximation has been made to fatty acid classes but, unavoidably, calculated sums of individual fatty acid totals do not always match industry data for fatty acid classes. Zero values for individual fatty acids should be understood to mean that trace amounts may be present. When g

fatty acids per 100 g of total lipid are converted to g fatty acids per 100 g of food, values of less than 0.0005 are rounded to 0.

Cholesterol. Cholesterol values are generated primarily by gas liquid chromatographic procedures (AOAC 994.10). Recent meat data has been determined by a GC method without derivitization (Dinh *et al*., 2008). It is assumed that cholesterol is present only in foods of animal origin and foods containing at least one ingredient of animal origin (for example, cake that contains eggs). For mixtures containing ingredients derived from animal products, the cholesterol value may be calculated from the value for those ingredients. For foods that contain only plant products, the value for cholesterol is assumed to be zero.

Plant sterols. Data on plant sterols (campesterol, stigmasterol, and β-sitosterol) are obtained by gas-chromatographic procedures (AOAC 967.18) and summed to calculate total phytosterols (Nutr. No. 636). Plant sterols for a number of nuts, seeds, mushrooms, and other food items were determined by a gas-chromatographic method developed by Phillips *et al*. (2005) which includes an acid hydrolysis step. These data include additional sterols such as ergosterol or delta-5-avenasterol and various stanols plus some minor sterols that are not disseminated in SR. When available, data on these phytosterols are provided in a footnote for the specific food item. In these cases, Nutrient No. 636, total phytosterols, is not disseminated for these food items.

***Amino Acids*.** Amino acid data for a class or species of food are aggregated to yield a set of values that serve as the pattern for calculating the amino acid profile of other similar foods. The amino acid values for the pattern are expressed on a per-gram-of-nitrogen basis. Amino acids are extracted in three groups—tryptophan, sulfur-containing amino acids (methionine and cystine), and all others. Tryptophan is determined by alkaline hydrolysis/HPLC (AOAC 988.15), methionine and cystine by performic oxidation/HPLC (AOAC 994.12) and all others by acid hydrolysis/HPLC (AOAC 982.30). Hydroxyproline in meats has been determined using a colorimetric method (AOAC 990.26). The amino acid patterns and the total nitrogen content are used to calculate the levels of individual amino acids per 100 g of food, using the following formula:

$$AA_f = (AA_n * V_p)/N_f$$

where:
AA_f = amino acid content per 100 g of food,
AA_n = amino acid content per g of nitrogen,
V_p = protein content of food, and
N_f = nitrogen factor.

For foods processed in the NDBS since SR14 (2001), the number of observations used in developing an amino acid pattern is released only with the pattern. The amino acid profiles calculated from these patterns will show the number of data points to be zero. In the past, the number of data points appeared only for the food item for which the amino

acid pattern was developed, not on other foods that used the same pattern. It referred to the number of observations used in developing the amino acid pattern for that food.

If amino acid values are presented for an item with more than one protein-containing ingredient, the values may be calculated on a per-gram-of-nitrogen basis from the amino acid patterns of the various protein-containing ingredients. Then the amino acid contents for an item on the 100-g basis are calculated as the sum of the amino acids in each protein-containing ingredient multiplied by total nitrogen in the item. The number of data points for these values is given as zero.

Weights and Measures

Information is provided on household measures for food items (for example, 1 cup, 1 tablespoon, 1 fruit, 1 leg). Weights are given for edible material without refuse, that is, the weight of an apple without the core or stem, or a chicken leg without the bone, and so forth. The Weight file contains the gram weights and measure descriptions for each food item. This file can be used to calculate nutrient values for food portions from the values provided per 100 g of food. The following formula is used to calculate the nutrient content per household measure:

$$N = (V*W)/100$$

where:

N = nutrient value per household measure,
V = nutrient value per 100 g (Nutr_Val in the Nutrient Data file), and
W = g weight of portion (Gm_Wgt in the Weight file).

The Weight file can be used to produce reports showing the household measure and nutrient values calculated for that portion. The weights are derived from published sources, industry files, studies conducted by USDA (Adams, 1975; Fulton *et al*., 1977), and the weights and measures used in the FNDDS (2012). However, weight information is not available for all food items in the database. Though special efforts have been made to provide representative values, weights and measures obtained from different sources vary considerably for some foods. The format of this file is described on p. 36.

Footnotes

Footnotes are provided for a few items where information about food description, weights and measures, or nutrient values could not be accommodated in existing fields. For example, if citric acid is added to a juice drink, this is indicated in the footnote. The format of this file is described on p. 36.

Sources of Data

The Sources of Data file (previously called References) was first added with SR14 (2001). The name of the file and fields reflect the fact that not all sources are journals or published literature, but also include the results of unpublished data from USDA-sponsored research and from research sponsored by others either separately or in collaboration with USDA. It contains data sources for the nutrient values and links to an identification number on each nutrient record. Nutrient-specific source documentation is not electronically available for data added prior to SR14 (2001). Data source information for these food items will be added when new data are generated and published in future releases. The format of this file is described on p. 37.

The Sources of Data Link file is provided to allow users to establish a relationship between the Sources of Data file and the Nutrient Data file. This lets the user identify specific sources of data for each nutrient value. For example, the user can use these files to determine the dates associated with source documents for a particular data value. These files can also be used to determine values obtained from a particular data source, for example where NFNAP data is used in the database. The format of this file is described on p.37.

Explanation of File Formats

The data appear in two different organizational formats. One is a relational format of four principal and six support files making up the database. The relational format is complete and contains all food, nutrient, and related data. The other is a flat abbreviated file with all the food items, but fewer nutrients, and not all of the other related information. The abbreviated file does not include values for starch, individual sugars, fluoride, betaine, vitamin D_2 or D_3, added vitamin E, added vitamin B_{12}, alcohol, caffeine, theobromine, phytosterols, individual amino acids, or individual fatty acids. See p. 38 for more information on this file.

Relational Files

The four principal database files are the Food Description file, Nutrient Data file, Gram Weight file, and Footnote file. The eight support files are the Food Group Description file, LanguaL Factor file, LanguaL Factor Description file, Nutrient Definition file, Source Code file, Data Derivation Code Description file, Sources of Data file, and Sources of Data Link file. Table 3 shows the number of records in each file. In a relational database, these files can be linked together in a variety of combinations to produce queries and generate reports. Figure 1 provides a diagram of the relationships between files and their key fields.

The relational files are provided in both ASCII (ISO/IEC 8859-1) format and a Microsoft Access 2007 database. Tables 4 through 13 describe the formats of these files. Information on the relationships that can be made among these files is also given.

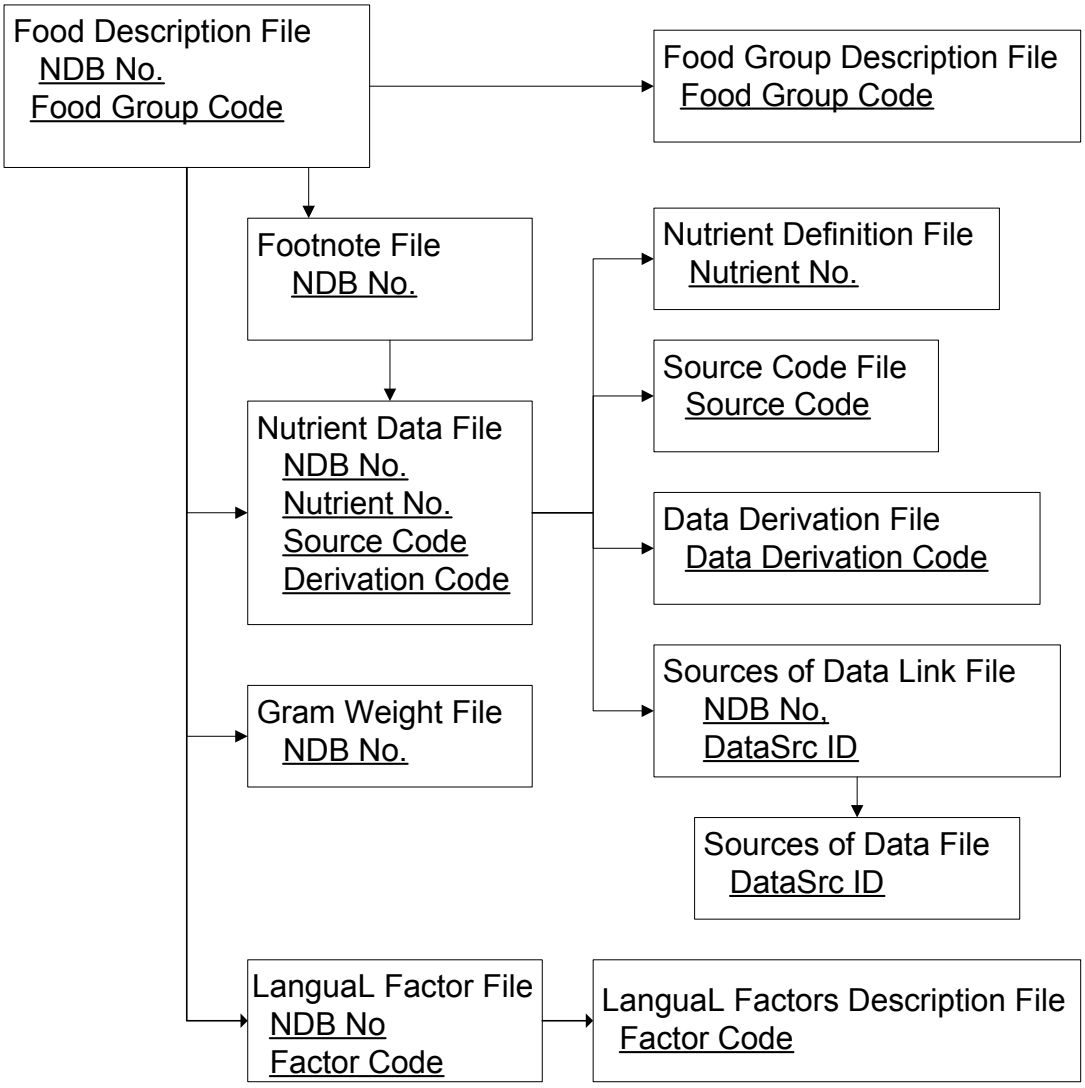
Fields that always contain data and fields that can be left blank or null are identified in the "blank" column; N indicates a field that is always filled; and Y indicates a field that may be left blank (null) (Tables 4-13). An asterisk (*) indicates primary key(s) for the file. Though keys are not identified for the ASCII files, the file descriptions show where keys are used to sort and manage records within the NDBS. When importing these files into a database management system, if keys are to be identified for the files, it is important to use the keys listed here, particularly with the Nutrient Data file, which uses two.

Table 3. – Number of Records in Principal and Support Files

File name	Table name	Number of records
Principal files		
Food Description (p. 29)	FOOD_DES	8,618
Nutrient Data (p. 32)	NUT_DATA	654,572
Weight (p. 36)	WEIGHT	15,228
Footnote (p. 36)	FOOTNOTE	531
Support files		
Food Group Description (p. 31)	FD_GROUP	25
LanguaL Factor (p. 31)	LANGUAL	38,725
LanguaL Factors Description (p. 31)	LANGDESC	774
Nutrient Definition (p. 34)	NUTR_DEF	150
Source Code (p. 34)	SRC_CD	10
Data Derivation Code Description (p. 35)	DERIV_CD	55
Sources of Data (p. 37)	DATA_SRC	655
Sources of Data Link (p. 37)	DATSRCLN	230,663

ASCII files are delimited. All fields are separated by carets (^) and text fields are surrounded by tildes (~). A double caret (^^) or two carets and two tildes (~~) appear when a field is null or blank. Format descriptions include the name of each field, its type [N = numeric with width and number of decimals (w.d) or A = alphanumeric], and maximum record length. The actual length in the data files may be less and most likely will change in later releases. Values will be padded with trailing zeroes when imported into various software packages, depending on the formats used.

Figure 1. Relationships among files in the USDA National Nutrient Database for Standard Reference *



* Underlined items denote key fields.

Food Description File (file name = FOOD_DES). This file (Table 4) contains long and short descriptions and food group designators for all food items, along with common names, manufacturer name, scientific name, percentage and description of refuse, and factors used for calculating protein and kilocalories, if applicable. Items used in the FNDDS are also identified by value of "Y" in the Survey field.

- Links to the Food Group Description file by the FdGrp_Cd field
- Links to the Nutrient Data file by the NDB_No field
- Links to the Weight file by the NDB_No field
- Links to the Footnote file by the NDB_No field
- Links to the LanguaL Factor file by the NDB_No field

Table 4.—Food Description File Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	5-digit Nutrient Databank number that uniquely identifies a food item. If this field is defined as numeric, the leading zero will be lost.
FdGrp_Cd	A 4	N	4-digit code indicating food group to which a food item belongs.
Long_Desc	A 200	N	200-character description of food item.
Shrt_Desc	A 60	N	60-character abbreviated description of food item. Generated from the 200-character description using abbreviations in Appendix A. If short description is longer than 60 characters, additional abbreviations are made.
ComName	A 100	Y	Other names commonly used to describe a food, including local or regional names for various foods, for example, “soda” or “pop” for “carbonated beverages.”
ManufacName	A 65	Y	Indicates the company that manufactured the product, when appropriate.
Survey	A 1	Y	Indicates if the food item is used in the USDA Food and Nutrient Database for Dietary Studies (FNDDS) and thus has a complete nutrient profile for the 65 FNDDS nutrients.
Ref_desc	A 135	Y	Description of inedible parts of a food item (refuse), such as seeds or bone.
Refuse	N 2	Y	Percentage of refuse.
SciName	A 65	Y	Scientific name of the food item. Given for the least processed form of the food (usually raw), if applicable.
N_Factor	N 4.2	Y	Factor for converting nitrogen to protein (see p. 12).
Pro_Factor	N 4.2	Y	Factor for calculating calories from protein (see p. 13).
Fat_Factor	N 4.2	Y	Factor for calculating calories from fat (see p. 13).
CHO_Factor	N 4.2	Y	Factor for calculating calories from carbohydrate (see p. 13).

* Primary key for the Food Description file.

Food Group Description File (file name = FD_GROUP). This file (Table 5) is a support file to the Food Description file and contains a list of food groups used in SR27 and their descriptions.

- Links to the Food Description file by FdGrp_Cd

Table 5.—Food Group Description File Format

Field name	Type	Blank	Description
FdGrp_Cd	A 4*	N	4-digit code identifying a food group. Only the first 2 digits are currently assigned. In the future, the last 2 digits may be used. Codes may not be consecutive.
FdGrp_Desc	A 60	N	Name of food group.

* Primary key for the Food Group Description file.

***LanguaL Factor* File** (File name = LANGUAL). This file (Table 6) is a support file to the Food Description file and contains the factors from the LanguaL Thesaurus used to code a particular food.

- Links to the Food Description file by the NDB_No field
- Links to LanguaL Factors Description file by the Factor_Code field

Table 6.—LanguaL Factor File Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	5-digit Nutrient Databank number that uniquely identifies a food item. If this field is defined as numeric, the leading zero will be lost.
Factor_Code	A 5*	N	The LanguaL factor from the Thesaurus

* Primary key for the LanguaL Factor file.

LanguaL Factors Description File (File name = LANGDESC). This file (Table 7) is a support file to the LanguaL Factor file and contains the descriptions for only those factors used in coding the selected food items codes in this release of SR.

- Links to the LanguaL Factor File by the Factor_Code field

Table 7.—LanguaL Factors Description File Format

Field name	Type	Blank	Description
Factor_Code	A 5*	N	The LanguaL factor from the Thesaurus. Only those codes used to factor the foods contained in the LanguaL Factor file are included in this file
Description	A 140	N	The description of the LanguaL Factor Code from the thesaurus

* Primary key for the LanguaL Factor Description file.

Nutrient Data File (file name = NUT_DATA)**.** This file (Table 8) contains the nutrient values and information about the values, including expanded statistical information.

- Links to the Food Description file by NDB_No
- Links to the Food Description file by Ref_NDB_No
- Links to the Weight file by NDB_No
- Links to the Footnote file by NDB_No and when applicable, Nutr_No
- Links to the Nutrient Definition file by Nutr_No
- Links to the Source Code file by Src_Cd
- Links to the Derivation Code file by Deriv_Cd

Table 8.—Nutrient Data File Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	5-digit Nutrient Databank number.
Nutr_No	A 3*	N	Unique 3-digit identifier code for a nutrient.
Nutr_Val	N 10.3	N	Amount in 100 grams, edible portion †.
Num_Data_Pts	N 5.0	N	Number of data points (previously called Sample_Ct) is the number of analyses used to calculate the nutrient value. If the number of data points is 0, the value was calculated or imputed.
Std_Error	N 8.3	Y	Standard error of the mean. Null if cannot be calculated. The standard error is also not given if the number of data points is less than three.
Src_Cd	A 2	N	Code indicating type of data.
Deriv_Cd	A 4	Y	Data Derivation Code giving specific information on how the value is determined. This field is populated only for items added or updated starting with SR14.

Field name	Type	Blank	Description
Ref_NDB_No	A 5	Y	NDB number of the item used to calculate a missing value. Populated only for items added or updated starting with SR14.
Add_Nutr_Mark	A 1	Y	Indicates a vitamin or mineral added for fortification or enrichment. This field is populated for ready-to-eat breakfast cereals and many brand-name hot cereals in food group 8.
Num_Studies	N 2	Y	Number of studies.
Min	N 10.3	Y	Minimum value.
Max	N 10.3	Y	Maximum value.
DF	N 4	Y	Degrees of freedom.
Low_EB	N 10.3	Y	Lower 95% error bound.
Up_EB	N 10.3	Y	Upper 95% error bound.
Stat_cmt	A 10	Y	Statistical comments. See definitions below.
AddMod_Date	A10	Y	Indicates when a value was either added to the database or last modified.
CC	A 1	Y	Confidence Code indicating data quality, based on evaluation of sample plan, sample handling, analytical method, analytical quality control, and number of samples analyzed. Not included in this release, but is planned for future releases.

* Primary keys for the Nutrient Data file.
† Nutrient values have been rounded to a specified number of decimal places for each nutrient. Number of decimal places is listed in the Nutrient Definition file.

Definitions of each statistical comment included in the Nutrient Data table follow:

1. The displayed summary statistics were computed from data containing a verbally described value, e.g., less than, trace or not-detected. This must be done in order to carry out any mathematical computations. In every case, the definition of the verbal value is used to derive a numeric value. By definition the actual verbal definition must be a value that falls between two or more numeric values, using a simple linear interpolation between these values. This will derive the most likely numeric location for the verbally described value by following simplest and least computationally intense imputation procedures. If there is a need to account for the added variance due to the imputation of the summary value, see Little and Rubin (2002). Further information is provided in Appendices D and E.

2. The displayed degrees of freedom were computed using Satterthwaite's approximation (Kotz and Johnson, 1988).
3. The procedure used to estimate the reliability of the generic mean requires that the data associated with each study be a simple random sample from all the products associated with the given data source (for example, manufacturer, variety, cultivar, and species). For this nutrient, one or more data sources had only one observation. Therefore, the standard errors, degrees of freedom, and error bounds were computed from the between-group standard deviation of the weighted groups having only one observation.

Nutrient Definition File (file name = NUTR_DEF). This file (Table 9) is a support file to the Nutrient Data file. It provides the 3-digit nutrient code, unit of measure, INFOODS tagname, and description.

- Links to the Nutrient Data file by Nutr_No

Table 9.—Nutrient Definition File Format

Field name	Type	Blank	Description
Nutr_No	A 3*	N	Unique 3-digit identifier code for a nutrient.
Units	A 7	N	Units of measure (mg, g, µg, and so on).
Tagname	A 20	Y	International Network of Food Data Systems (INFOODS) Tagnames.† A unique abbreviation for a nutrient/food component developed by INFOODS to aid in the interchange of data.
NutrDesc	A 60	N	Name of nutrient/food component.
Num_Dec	A 1	N	Number of decimal places to which a nutrient value is rounded.
SR_Order	N 6	N	Used to sort nutrient records in the same order as various reports produced from SR.

* Primary key for the Nutrient Definition file.
† INFOODS, 2014.

Source Code File (file name = SRC_CD). This file (Table 10) contains codes indicating the type of data (analytical, calculated, assumed zero, and so on) in the Nutrient Data file. To improve the usability of the database and to provide values for the FNDDS, NDL staff imputed nutrient values for a number of proximate components, total dietary fiber, total sugar, and vitamin and mineral values.

- Links to the Nutrient Data file by Src_Cd

Table 10.—Source Code File Format

Field name	Type	Blank	Description
Src_Cd	A 2*	N	2-digit code.
SrcCd_Desc	A 60	N	Description of source code that identifies the type of nutrient data.

* Primary key for the Source Code file.

Data Derivation Code Description File (file name = DERIV_CD). This file (Table 11) provides information on how the nutrient values were determined. The file contains the derivation codes and their descriptions.

- Links to the Nutrient Data file by Deriv_Cd

Table 11.—Data Derivation Code File Format

Field name	Type	Blank	Description
Deriv_Cd	A 4*	N	Derivation Code.
Deriv_Desc	A 120	N	Description of derivation code giving specific information on how the value was determined.

* Primary key for the Data Derivation Code file.

For example, the data derivation code that indicates how α-tocopherol (Nutrient No. 323) in Emu, fan fillet, raw (NDB. No. 05623) was calculated is BFSN. The breakdown of the code is as follows:

B = based on another form of the food or a similar food;
F = concentration adjustment used;
S = solids, the specific concentration adjustment used; and
N = retention factors not used.

The Ref_NDB_No is 05621 Emu, ground, raw. This means that the analytical α-tocopherol value in the total solids of emu, ground, raw is used to calculate the α-tocopherol in the total solids of emu, fan fillet, raw.

$$N_t = (N_s * S_s)/S_t$$

where:
N_t = the nutrient content of the target item,
N_s = the nutrient content of the source item,
For NDB No. 05621, α-tocopherol = 0.24 mg/100 g
S_s = the total solids content of the source item, and
For NDB No. 05621, solids = 27.13 g/100 g

S_t = the total solids content of the target item.
For NDB No. 05623, solids = 2538 g/100 g

So, using this formula for the above example:

N_t = (0.24 × 25.38)/27.13 = 0.22 mg/100 g α-tocopherol in Emu, fan fillet, raw

Only items that were imputed starting with SR14 (2001) will have both derivation codes and reference NDB numbers. Other items that have been imputed outside the NDBS will have data derivation codes, but the Ref_NDB_No field will be blank.

Weight File (file name = WEIGHT). This file (Table 12) contains the weight in grams of a number of common measures for each food item.

- Links to Food Description file by NDB_No
- Links to Nutrient Data file by NDB_No

Table 12.— Weight File Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	5-digit Nutrient Databank number.
Seq	A 2*	N	Sequence number.
Amount	N 5.3	N	Unit modifier (for example, 1 in “1 cup”).
Msre_Desc	A 84	N	Description (for example, cup, diced, and 1-inch pieces).
Gm_Wgt	N 7.1	N	Gram weight.
Num_Data_Pts	N 3	Y	Number of data points.
Std_Dev	N 7.3	Y	Standard deviation.

* Primary key for the Weight file.

Footnote File (file name = FOOTNOTE)**.** This file (Table 13) contains additional information about the food item, household weight, and nutrient value.

- Links to the Food Description file by NDB_No
- Links to the Nutrient Data file by NDB_No and when applicable, Nutr_No
- Links to the Nutrient Definition file by Nutr_No, when applicable

Table 13.—Footnote File Format

Field name	Type	Blank	Description
NDB_No	A 5	N	5-digit Nutrient Databank number.
Footnt_No	A 4	N	Sequence number. If a given footnote applies to more than one nutrient number, the same footnote number is used. As a result, this file cannot be indexed.
Footnt_Typ	A 1	N	Type of footnote: D = footnote adding information to the food description; M = footnote adding information to measure description; N = footnote providing additional information on a nutrient value. If the Footnt_typ = N, the Nutr_No will also be filled in.
Nutr_No	A 3	Y	Unique 3-digit identifier code for a nutrient to which footnote applies.
Footnt_Txt	A 200	N	Footnote text.

Sources of Data Link File (file name = DATSRCLN). This file (Table 14) is used to link the Nutrient Data file with the Sources of Data table. It is needed to resolve the many-to-many relationship between the two tables.

- Links to the Nutrient Data file by NDB No. and Nutr_No
- Links to the Nutrient Definition file by Nutr_No
- Links to the Sources of Data file by DataSrc_ID

Table 14.—Sources of Data Link File Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	5-digit Nutrient Databank number.
Nutr_No	A 3*	N	Unique 3-digit identifier code for a nutrient.
DataSrc_ID	A 6*	N	Unique ID identifying the reference/source.

* Primary key for the Sources of Data Link file.

Sources of Data File (file name = DATA_SRC). This file (Table 15) provides a citation to the DataSrc_ID in the Sources of Data Link file.

- Links to Nutrient Data file by NDB No. through the Sources of Data Link file

Table 15.—Sources of Data File Format

Field name	Type	Blank	Description
DataSrc_ID	A 6*	N	Unique number identifying the reference/source.
Authors	A 255	Y	List of authors for a journal article or name of sponsoring organization for other documents.
Title	A 255	N	Title of article or name of document, such as a report from a company or trade association.
Year	A 4	Y	Year article or document was published.
Journal	A 135	Y	Name of the journal in which the article was published.
Vol_City	A 16	Y	Volume number for journal articles, books, or reports; city where sponsoring organization is located.
Issue_State	A 5	Y	Issue number for journal article; State where the sponsoring organization is located.
Start_Page	A 5	Y	Starting page number of article/document.
End_Page	A 5	Y	Ending page number of article/document.

* Primary key for the Sources of Data file.

Abbreviated File

The Abbreviated file **(**file name = ABBREV) is available in ASCII format and as a Microsoft Excel spreadsheet. It contains all the food items found in the relational database, but with fewer nutrients and other related information. The abbreviated file does not include values for starch, fluoride, betaine, vitamin D_2 and D_3, added vitamin E, added vitamin B_{12}, alcohol, caffeine, theobromine, phytosterols, individual amino acids, individual fatty acids, or sugars. Table 16 lists all the nutrients included in the abbreviated file. Starting with SR22 (2009), Vitamin D in µg and IU was added to the Abbreviated file. The ASCII file (Table 16) is in delimited format. Fields are separated by a caret (^) and text fields are surrounded by tildes (~). Data refer to 100 g of the edible portion of the food item. Decimal points are included in the fields. Missing values are denoted by the null value of two consecutive carets (^^) or two carets and two tildes (~~). The file is sorted in ascending order by the NDB number. Two common measures are provided, which are the first two common measures in the Weight file for each NDB number. To obtain values per one of the common measures, multiply the value in the desired nutrient field by the value in the desired common measure field and divide by 100. For example, to calculate the amount of fat in 1 tablespoon of butter (NDB No. 01001):

V_H=(N*CM)/100

where:
V_H = the nutrient content per the desired common measure,
N = the nutrient content per 100 g,
For NDB No. 01001, fat = 81.11 g/100 g
CM = grams of the common measure.
For NDB No. 01001, 1 tablespoon = 14.2 g

So using this formula for the above example:

V_H = (81.11*14.2)/100 = 11.52 g fat in 1 tablespoon of butter

This file is a flat file and is provided for those users who do not need a relational database. It contains the information in one record per food item and is suitable for importing into a spreadsheet. The data file has been imported into a Microsoft Excel 2007 spreadsheet for users of that application. Users of other software applications can import either the Microsoft Excel 2007 spreadsheet or the ASCII files. If additional information is needed, this file can be linked to the other SR files by the NDB number.

Table 16.—Abbreviated File Format

Field name	Type	Description
NDB_No.	A 5*	5-digit Nutrient Databank number.
Shrt_Desc	A 60	60-character abbreviated description of food item.†
Water	N 10.2	Water (g/100 g)
Energ_Kcal	N 10	Food energy (kcal/100 g)
Protein	N 10.2	Protein (g/100 g)
Lipid_Tot	N 10.2	Total lipid (fat)(g/100 g)
Ash	N 10.2	Ash (g/100 g)
Carbohydrt	N 10.2	Carbohydrate, by difference (g/100 g)
Fiber_TD	N 10.1	Total dietary fiber (g/100 g)
Sugar_Tot	N 10.2	Total sugars (g/100 g)
Calcium	N 10	Calcium (mg/100 g)
Iron	N 10.2	Iron (mg/100 g)
Magnesium	N 10	Magnesium (mg/100 g)
Phosphorus	N 10	Phosphorus (mg/100 g)
Potassium	N 10	Potassium (mg/100 g)
Sodium	N 10	Sodium (mg/100 g)

Field name	Type	Description
Zinc	N 10.2	Zinc (mg/100 g)
Copper	N 10.3	Copper (mg/100 g)
Manganese	N 10.3	Manganese (mg/100 g)
Selenium	N 10.1	Selenium (µg/100 g)
Vit_C	N 10.1	Vitamin C (mg/100 g)
Thiamin	N 10.3	Thiamin (mg/100 g)
Riboflavin	N 10.3	Riboflavin (mg/100 g)
Niacin	N 10.3	Niacin (mg/100 g)
Panto_acid	N 10.3	Pantothenic acid (mg/100 g)
Vit_B6	N 10.3	Vitamin B_6 (mg/100 g)
Folate_Tot	N 10	Folate, total (µg/100 g)
Folic_acid	N 10	Folic acid (µg/100 g)
Food_Folate	N 10	Food folate (µg/100 g)
Folate_DFE	N 10	Folate (µg dietary folate equivalents/100 g)
Choline_Tot	N 10	Choline, total (mg/100 g)
Vit_B12	N 10.2	Vitamin B_{12} (µg/100 g)
Vit_A_IU	N 10	Vitamin A (IU/100 g)
Vit_A_RAE	N 10	Vitamin A (µg retinol activity equivalents/100g)
Retinol	N 10	Retinol (µg/100 g)
Alpha_Carot	N 10	Alpha-carotene (µg/100 g)
Beta_Carot	N 10	Beta-carotene (µg/100 g)
Beta_Crypt	N 10	Beta-cryptoxanthin (µg/100 g)
Lycopene	N 10	Lycopene (µg/100 g)
Lut+Zea	N 10	Lutein+zeazanthin (µg/100 g)
Vit_E	N 10.2	Vitamin E (alpha-tocopherol) (mg/100 g)
Vit_D_mcg	N 10.1	Vitamin D (µg/100 g)
Vit_D_IU	N 10	Vitamin D (IU/100 g)
Vit_K	N 10.1	Vitamin K (phylloquinone) (µg/100 g)
FA_Sat	N 10.3	Saturated fatty acid (g/100 g)
FA_Mono	N 10.3	Monounsaturated fatty acids (g/100 g)
FA_Poly	N 10.3	Polyunsaturated fatty acids (g/100 g)

Field name	Type	Description
Cholestrl	N 10.3	Cholesterol (mg/100 g)
GmWt_1	N 9.2	First household weight for this item from the Weight file.‡
GmWt_Desc1	A 120	Description of household weight number 1.
GmWt_2	N 9.2	Second household weight for this item from the Weight file.‡
GmWt_Desc2	A 120	Description of household weight number 2.
Refuse_Pct	N 2	Percent refuse.§

* Primary key for the Abbreviated file.
† For a 200-character description and other descriptive information, link to the Food Description file.
‡ For the complete list and description of the measure, link to the Weight file.
§ For a description of refuse, link to the Food Description file.

Update Files

The update files contain changes made between the last release, SR26 (2013), and the current release, SR27 (2014). Update files in ASCII are provided for those users who reformatted previous releases for their systems and wish to do their own updates. If a release earlier than SR26 is used, it is necessary to first obtain the update files for that release through SR26, update the database to SR26, and then use the update files provided with SR27. Update files from previous releases are available on NDL's web site: http://www.ars.usda.gov/nutrientdata.

New data added to SR27 are given in the following files:
- ADD_FOOD for descriptions of the new items (307 records);
- ADD_NUTR for added nutrient data (30,317 records);
- ADD_WGT for added weight and measure data (398 records); and
- ADD_FTNT for added footnotes (14 records).

These files are in the same formats as the Food Description file, the Nutrient Data file, the Weight file, and the Footnote file.

Five files contain changes made since SR26 (2013):
- CHG_FOOD contains records with changes in the descriptive information for a food item (310 records);
- CHG_NUTR contains changes to the following fields: nutrient values, standard errors, number of data points, source code, and data derivation code (20,278 records);

- CHG_WGT contains records with changes to the gram weights or measure information (300 records); and
- CHG_FTNT contains records with changes to footnotes (10 records).
- CHG_NDEF contains records with changes to the nutrient definitions (1 record)

If the values in any fields have changed, the entire record is included for that file. These files are in the same format as the Food Description, Nutrient Data, Weight, Footnote, and Nutrient Definition files.

Four files contain records that were deleted since SR26 (2013):
- DEL_FOOD file (Table 17) lists those food items that were deleted from the database (152 records);
- DEL_NUTR file (Table 18) lists those nutrient values that were removed from the database (8,639 records);
- DEL_WGT contains any gram weights that were removed (307 records). These records are in the same format as the Weight file (Table 12); and
- DEL_FTNT contains any footnotes that were removed from the database (Table 19). Starting with SR19, if a given footnote applied to more than one nutrient number, the same footnote number can be used. When these footnote numbers are updated, the extra footnotes are deleted (27 records).

Table 17.—Foods Deleted Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	Unique 5-digit number identifying deleted item.
Shrt_Desc	A 60	N	60-character abbreviated description of food item.

* Primary key for Foods Deleted file.

Table 18. —Nutrients Deleted Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	Unique 5-digit number identifying the item that contains the deleted nutrient record.
Nutr_No	A 3	N	Nutrient number of deleted record.

* Primary key for Nutrients Deleted file.

Table 19.—Footnotes Deleted Format

Field name	Type	Blank	Description
NDB_No	A 5*	N	Unique 5-digit number identifying the item that contains the deleted nutrient record.
Footnt_No	A 4	N	Sequence number.
Footnt_Typ	A 1	N	Type of footnote of deleted record.

* Primary key for Footnotes Deleted file.

Update files in ASCII are also provided for the Abbreviated file:

- CHG_ABBR file contains records for food items where a food description, household weight, refuse value, or nutrient value have been added, changed, or deleted since SR26. This file is in the same format as the Abbreviated file (Table 16);
- DEL_ABBR contains food items that have been removed from the database; it is in the same format as DEL_FOOD; and
- ADD_ABBR contains food items added since SR26; it is also in the same format as the Abbreviated file.

Summary

A number of food items have been added to the database using new data from NFNAP, the food industry, and other sources. Other foods have had nutrient values updates. In particular, the sodium content of those foods which are major contributors of sodium to the diet—primarily commercially processed and restaurant foods— has been targeted for nutrient analysis. A number of food items, no longer on the market, such as certain processed foods, have been removed. These are described in “Specific Changes for SR27” (p. 2). The next release, SR28, available in 2015, will contain additional items and updates.

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* Available on NDL's web site: http://www.ars.usda.gov/nutrientdata.

Notes on Foods

Introduction

The information contained in ”Notes on Foods” was initially published in printed copies of Agriculture Handbook No. 8 (AH-8), which were presented as individual sections by food groups. In addition to a description of the tables and how nutrient values were determined, each food group section included a portion, called “Notes on Foods” with information specific to each food group. The information on the database, nutrient values and formats has been published separately as the documentation accompanying each release of the USDA National Nutrient Database for Standard Reference (SR; NDL, 2013). At this time, “Notes on Foods” are included in this document for only some of the sections previously available in the printed copies. It is anticipated that this document will expand, as information for the remaining food groups is added.

Data are obtained from a variety of sources (Figure 2). These include the scientific literature, data provided by food companies and trade associations, other government agencies and USDA-sponsored contracts. In a number of cases, various trade associations have worked with the Nutrient Data Laboratory (NDL) to design analytical studies to obtain new data on various food items. These studies are described in greater detail in their respective sections below. Since 1997, USDA-sponsored contracts have been conducted under the aegis of the National Food and Nutrient Analysis Program (NFNAP), which is described below.

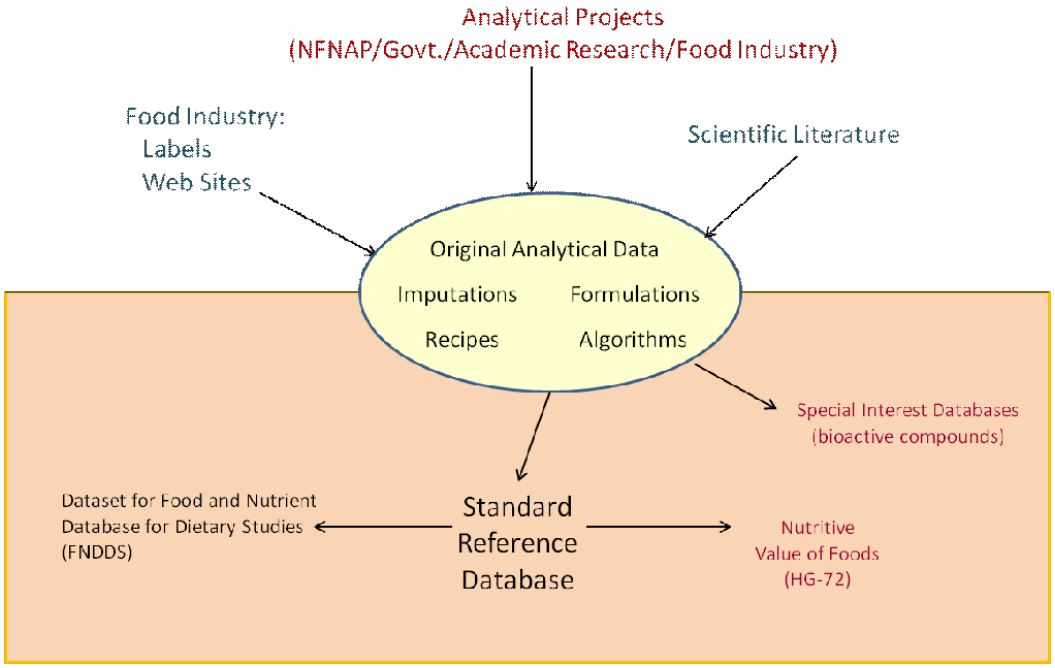

Figure 2. Sources of data and NDL products

National Food and Nutrient Analysis Program

In 1997, the NDL, in cooperation with the National Heart Lung and Blood Institute and other Institutes and Offices of the National Institutes of Health (NIH), instituted the National Food and Nutrient Analysis Program. In 2005, The National Cancer Institute took over the lead role in coordinating the program at NIH. The goals of NFNAP are to improve the quantity and quality of data in the USDA National Nutrient Databank which has resulted in annual updates of the USDA National Nutrient Database for Standard Reference (USDA, 2014) and a number of Special Interest Databases: isoflavones (USDA, 2008), choline (USDA, 2004a), proanthocyanidins (USDA, 2004b), fluoride (USDA, 2005), and flavonoids (USDA, 2013). To achieve these goals, five principle aims were established:

1. Identify and rank foods and nutrients for analysis;
2. Evaluate existing data for foods and nutrients;
3. Develop strategies for sampling;
4. Process and analyze foods; and
5. Review and disseminate results.

Since its inception in 1997, over 1,900 unique food items have been sampled and analyzed under NFNAP—some of these have been sampled and analyzed more than once as products and formulations have changed. To date, values for over 1,600 of these food items have been incorporated into SR. The process of acquiring, evaluating, and disseminating food composition data is continuous. At any time, new samples are being collected, prepared and analyzed and data for samples already analyzed are being revised and processed through NDL's Nutrient Data Bank System (NDBS). Details of these studies are described in specific chapters on each food group, which follow this section. A number of trade associations in the food industry, such as the National Cattleman's Beef Association, the National Pork Board, the Produce for Better Health Foundation, the Mushroom Council, the American Egg Board and others have worked with NDL to analyze food items in their product category sectors, using protocols adapted as part of NFNAP. Details of each of these studies are described in the specific chapter for each food group.

Identify Key Foods and critical nutrients for sampling and analysis

To identify and rank foods and nutrients for analysis, the Key Foods approach (Haytowitz *et al*., 2000; Haytowitz *et al*., 2002) was used. Key Foods are those foods which in aggregate contribute 75% of the nutrient intake for selected nutrients of public health importance from the diet. The most current Key Foods list was generated using weighted two-day food consumption data from the National Health and Nutrition Examination Survey (NHANES) 2007-08 Data Files (NCHS, 2010) and food composition data from SR22 (issued in 2009). For the current Key Foods list, targeted nutrients (total fat, food energy, total sugar, total dietary fiber, calcium, iron, potassium, sodium, β-carotene, α-tocopherol, vitamin C, vitamin B_{12}, choline, cholesterol and saturated fatty acids) were those identified in the Dietary Guidelines Advisory

Committee Report on the *Dietary Guidelines for Americans*, 2010 (DGAC, 2010) and the *Dietary Guidelines for Americans*, 2010 (USDA & USDHHS, 2010) as "shortfall" nutrients (limited in the diet) or nutrients of excess consumption, in particular those associated with poor health outcomes. Other nutrients of concern such as *trans* fatty acids were considered but not included in the Key Foods algorithm as only those nutrients included in the Food and Nutrient Database for Dietary Surveys (FNDDS), 5.0 (USDA-ARS, 2012) can be used. The Key Foods approach has allowed NDL to concentrate analytical resources on those foods that contribute significant amounts of nutrients of public health interest to the diet.

Evaluate existing data for scientific quality

At the initiation of NFNAP in 1997, the food composition values in SR were reviewed for scientific quality by NDL staff. Data for many of the foods in the database at that time were found to be more than 10 years old, based on a limited number of values, lacking in complete and accurate documentation, and including some samples of uncertain origin. To assess the quality of existing data and to improve the level of documentation, NDL scientists developed an expert system for evaluating data quality (Holden *et al*., 2002; Holden *et al*., 2005). The expert system focuses on evaluation and documentation of five data quality indicators: 1) sampling plan; 2) sample handling; 3) number of samples analyzed; 4) analytical methodology; and 5) analytical quality control. This system has been used in the production of a number of special interest databases including isoflavones (USDA, 2008), choline (USDA, 2004a), proanthocyanidins (USDA, 2004b), fluoride (USDA, 2005), and flavonoids (USDA, 2007). This process is used to provide information on the data quality assessment for all of the analytical nutrient profiles for foods in SR. Many of the food profiles in the database lacked some or all of the data quality information. For these reasons, and to establish a core set of data of known sampling, analytical methodology, and quality control, NDL determined that comprehensive updates of the food items on the Key Foods list would be needed.

Devise and implement a probability-based sampling survey of US foods

A probability-proportional-to-size (PPS) food sampling plan was developed by NDL staff in collaboration with statisticians from the National Agricultural Statistics Service, USDA (Pehrsson *et al*., 2000). This approach allows the development of nationally representative data for a given food. The original NFNAP food product sampling design was based on a stratified design including each of four regions across the 48 conterminous states of nearly equal in population size. A revised PPS sampling design was developed with 2000 US Census data (Perry *et al.*, 2003) and was based on a stratified three-stage design using 2001 Census Bureau projected state population sizes and Census regions (US Census Bureau, 2002). Forty-eight geographically dispersed counties were selected at the first stage, supermarket outlets at the second stage, and specific food products at the third stage. Subsets of these locations can be selected according to the requirements of the specific food item and nutrients, weighing variability vs. reliability. Multiples of these geographic locations can also be employed

for studies requiring more samples, i.e., where wide variability in a nutrient is expected and/or existing data are limited or nonexistent. Fluoride, for example, is highly variable in drinking water; in a national USDA study, drinking water was sampled in 144 locations and over two seasons (Pehrsson *et al.,* 2006). Another consideration in designing the sampling strategy was that fewer samples would be analyzed for lower consumption foods as identified during the Key Foods process or for nutrients in foods which were not significant contributors to the diet or present in low or trace concentrations. Details of the sampling design are discussed in Perry *et al*. (2003). A new sampling plan based on data from the 2010 US Census has been developed (Perry *et al.*, 2013) and will be used for future sample pickups.

Specific food products were selected according to a sampling approach based on market share. For example, after examining the Key Foods list, it was determined that pizza was a major contributor of many nutrients. Since both pizzas purchased from a fast food pizza restaurant vs. those purchased frozen and heated and served at home are commonly consumed, NDL undertook the analysis of both types. Several different types (e.g., cheese, pepperoni, pepperoni and sausage, and meat/vegetable combinations) and brands (e.g., major national brands and store brands) were purchased in supermarkets as described above. Later, several different types (e.g., cheese, pepperoni, and deluxe) of fast food restaurant pizza from major national chains were purchased from individual restaurants. For frozen pizzas, national composites of each type and brand were prepared. For the fast food restaurant pizzas, four composites of three randomly drawn samples of each type and brand were prepared.

Foods were purchased under contract by a USDA-directed professional product pickup company using tested selection protocols in retail outlets. The foods were shipped to the Food Analysis Laboratory Control Center (FALCC) at Virginia Tech in Blacksburg, Virginia for sample preparation. Procedures were developed for sample unit receipt, preparation, and storage which can be modified as needed for new food samples. FALCC continuously develops protocols for homogenizing and compositing samples based on instructions from NDL. FALCC also collects relevant weights and dissection information for edible and non-edible portions as required, and documents processing and preparation procedures. Processed samples are shipped to USDA-qualified analytical laboratories for analysis as directed by NDL. Reserve and archive samples of each food are maintained at FALCC.

The sampling plan can be modified to meet the requirements of a specific study of specific nutrients or unique foods, e.g., the sampling of tap water in homes to determine fluoride levels. With modifications, the sampling plan can be used for special population groups located in geographically distinct areas (e.g., American Indians and Alaska Natives on reservations, and Hispanic Americans (Perry *et al.,* 2002)).

Analyze sampled foods under USDA-supervised laboratory contracts

NDL employs a two-step process for awarding contracts for analysis of foods. The first step requires prospective contractors to submit a formal proposal. Prospective

contractors are asked to include a study plan in their proposal with detailed plans and procedures for conducting the nutrient analysis of Key Foods, as well as identifying the analytical methods and procedures they will use to complete each task. The description of analytical methods includes sample handling and storage, extraction or digestion, analysis, and quantification steps performed as part of the analysis. The laboratories propose specific analytical methods, based on their expertise, which are examined by NDL during the review of the proposals. A detailed discussion of day-to-day quality control (QC) procedures is requested to facilitate the assessment of accuracy and precision for the unknown samples. The commercial laboratory proposals are evaluated by a panel consisting of NDL and other ARS staff members. The proposals are reviewed and scored against criteria delineated in the Request for Proposals.

Those offerors whose proposals are deemed technically acceptable are sent "check" samples by FALCC for analysis. These are Certified Reference Materials (CRMs) procured from a variety of sources, both in the US and at the global level. Nutrient-specific analytical results generated by offerors for these samples are evaluated against acceptable ranges prepared by NDL. Offerors with the best written proposals and analytical results on the check samples may be awarded a contract for specific nutrients. Specific work orders under each contract are awarded such that contractors will not be given analytical work for nutrients where results for the check samples were outside the acceptable range.

Aliquots of each food composite are sent to the laboratories by FALCC for analysis according to the work plans developed by NDL. The methods of analysis employed by the various analytical laboratories are given in Table 20. Along with the samples, FALCC includes a QC material, which is either a control composite developed at FALCC or a CRM purchased from a certifying organization (Phillips *et al*., 2006). The laboratories are required to provide the results of their in-house quality control runs with the results for the analytical samples. The results from the laboratories are then reviewed by a quality control committee comprised of NDL and FALCC staff. The QC data for CRMs are compared to the certificate values for the material and the results for control composites are compared to a database of all results obtained for the particular control composites. Analytical data for food samples are compared to existing data for that food or a similar food. Questions are referred to the laboratories, and, if necessary, the analyses are repeated.

Table 20. Methods of analysis used by NFNAP laboratories

Nutrient	Technique	Methods Identification
Protein (Nitrogen)	Combustion	AOAC 968.06 (4.2.04) Protein (Crude) in Animal Feed
	Combustion	AOAC 990.03 Protein (Crude) in Animal Feed
	Combustion	AOAC 992.15 (39.1.16) Crude Protein in Meat and Meat Products Including Pet Foods
	Kjeldahl	AOAC 991.20 Nitrogen (Total) in Milk
Total Fat	Acid hydrolysis	AOAC 989.05 (33.2.26) Fat in Milk, Mojo, Acid Hydrolysis
	Acid hydrolysis	AOAC 922.06 (32.1.14) Fat in Flour, Acid Hydrolysis Method
	Acid hydrolysis	AOAC 925.12 (32.5.05) Fat in Macaroni Products

Nutrient	Technique	Methods Identification
	Acid hydrolysis	AOAC 954.02 (4.5.02 or 7.063) Fat (Crude) or Ether Extract in Pet Food
	Extraction	AOAC 920.39 Fat (Crude) or Ether Extract in Animal Feed
	Extraction	AOAC 933.05 Fat in Cheese
	Extraction	AOAC 960.39 (39.1.05) Fat (Crude) or Ether Extract in Meat
	Extraction	AOAC 983.23 (45.4.02) Fat in Foods, Chloroform-Methanol Extraction Method
	Extraction	Folch *et al*., (1957) J. Biol. Chem., 226; 497-509.
	Extraction	Phillips *et al*. Simplified Gravimetric Determination of Total Fat in Mixed Food Composites After Chloroform/Methanol Extraction J. Amer. Oil Chem. Soc., 74 (1997)p. 137-142
	Extraction	AOAC 989.05 Fat in Milk
Ash	Gravimetric	AOAC 923.03 (32.1.05 or 14.006) Ash of Flour
	Gravimetric	AOAC 942.05 (4.1.10) Ash of Animal Feed
	Gravimetric	AOAC 945.46 Ash of Milk
Moisture	Vacuum oven	AOAC 934.01 (4.1.03) Moisture in Animal Feed
	Vacuum oven	AOAC 934.06 (37.1.10) Moisture in Fruits, Vegetables, and their Products
	Vacuum oven	AOAC 964.22 (42.1.05) Solids (Total) in Canned Vegetables: Gravimetric Method
	Forced air	AOAC 950.46 (39.1.02) Moisture in Meat
Fiber	Enzymatic-gravimetric	AOAC 991.43 (32.1.17) Total, Soluble, and Insoluble Dietary Fiber in Foods
	Enzymatic-gravimetric	AOAC 985.29 (45.4.07) Total Dietary Fiber in Foods
Starch	Enzymatic-colorimetric	AOAC 979.10 (32.2.05) Starch in Cereals, Glucoamylase Method
	Polarimetric	The Feedings Stuffs (Sampling and Analysis) Regulations 1982 No. 1144, Agriculture, London
Sugars	LC	AOAC 982.14 (32.2.07) Glucose, Fructose, Sucrose, and Maltose in Presweetened Cereals
Minerals	ICP	AOAC 984.27 Ca, Cu, Fe, Mg, Mn, P, K, Na and Zn in Infant Formula
	Atomic absorption	Laboratory modified AOAC 968.08 (4.8.02) + 985.35 (50.1.14) + 965.05 (2.6.01) Metals in Food by AAS
	ICP	Laboratory modified AOAC 985.01 (3.2.06) + 984.27 (50.1.15) Metals in Food by ICP
Selenium	Isotope dilution GC/MS	Reamer & Veillon, Anal. Chem., 53, (1981) 2166
	Hydride generation	AOAC 986.15 (9.1.01) Arsenic, Cadmium, Lead, Selenium and Zinc in Human and Pet Foods
Retinol	HPLC	AOAC 974.29 (modified for HPLC) Vitamin A in Mixed Feeds, Premixes, and Foods and Int'l Vitamin Nutrition (1992) (modified for HPLC determination) or a laboratory modified method with UV & fluorescent detection
Fluoride	Specific ion electrode	VanWinkle, Levy *et al*., Pediatr. Dent., 17 (1995) p305 (direct-read)
	Microdiffusion	VanWinkle, Levy *et al*., Pediatr. Dent., 17 (1995) p305 (microdiffusion)
Vitamin E	GC	Cort *et al*., J Agr Food Chem (1983) 31:1330-1333 + Speek *et al*., J Food Sci (1985) 50:121-124 + McMurray *et al*., J AOAC (1980) 63:1258-1261

Nutrient	Technique	Methods Identification
	LC	Ye, Landen, Eitenmiller J Agric Food Chem. 2000 Sep;48(9):4003-8.
Carotenoids	HPLC	AOAC 941.15 (45.1.03) modified by Quackenbush, J. Liq. Chroma. (1987) 10:643-653
	HPLC	Craft, N. 2001. Chromatographic techniques for carotenoid separation. *In* Current Protocols in Food Analytical Chemistry. F2.3.1−F2.3.15. Wrolstad, R. E., Acree, T. E., Decker, E. A., Penner, M. H., Reid, D. S., Schwartz, S. J., Shoemaker, C. F., Sporns, P., Editors. Wiley.. New York.
Thiamin	Fluorometric	AOAC 942.23 Thiamine (B1) in Foods
Riboflavin	Microbiological	Laboratory modified AOAC 940.33 (45.2.06) Riboflavin (Vitamin B2) in Vitamin Preparations
	Fluorometric	AOAC 970.65 Riboflavin (Vitamin B2) in Foods and Vitamin Preparations (Fluorometric)
Niacin	Microbiological	Laboratory modified AOAC 944.13 (45.2.04) Niacin and Niacinamide (Nicotinic Acid and Nicotinamide) in Vitamin Preparations
Pantothenic acid	Microbiological	AOAC 945.74 (45.2.05) Pantothenic Acid in Vitamin Preparations
	Microbiological	AOAC 992.07 (50.1.22) Pantothenic Acid in Milk-Based Infant Formula
Vitamin B6	Microbiological	AOAC 961.15 (45.2.08) Vitamin B6 (Pyridoxine, Pyridoxal, and Pyridoxamine) in Food Extracts (Microbiological)
Vitamin B12	Microbiological	AOAC 952.20 (45.2.02) Cobalamin (Vitamin B12 Activity) in Vitamin Preparations
Total folate	Microbiological	Martin *et al*. J Assoc Off Anal Chem. 1990 Sep-Oct;73(5):805-8.
Choline	LC/ESI/MS	Koc *et al*. (Zeisel), Quantitation of Choline and its Metabolites in Tissues and Foods by LC/ESI/MS. Anal. Chem. (2002) 74:4734-4740
Vitamin D	LC	AOAC 995.05 (50.1.23) Vitamin D in Infant Formulas and Enteral Products
	HPLC	AOAC 982.29 (45.1.22) Vitamin D in Mixed Feeds, Premixes, and Pet Foods
	HPLC	Birdwell *et al*. Am J Clin Nutr **88** (2008) 554S-557S
	LC/MS/MS	Huang, Luzerne, Winters & Sullivan, JAOAC Int., 92 (2009) p1327-1335
Vitamin C	Microfluorometric	AOAC 967.22 (45.1.15) Vitamin C (Total) in Vitamin Preparations
Vitamin K	HPLC	Booth & Sadowski, Methods Enzymol., (1997) 282:446 (HPLC)
Cholesterol	GC/Direct saponification	AOAC 994.10 (45.4.10) Cholesterol in Foods
	GC/Direct saponification	Dinh *et al*. J Food Comp Anal, 21 (2008) p306-314
	Acid Hydrolysis-HPLC	AOAC 982.30 (45.3.05) (modified) Protein Efficiency Ratio (Ninhydrin post column)
	Alk. hydrolysis-HPLC	AOAC 988.15 (modified) Tryptophan in Foods and Food and Feed Ingredients
	Colorimetric	990.26 (39.1.27) Hydroxyproline in Meat and Meat products
	Performic oxidation-HPLC	994.12 (4.1.11) (modified) Amino Acids in Feed (OPA post column)

Nutrient	Technique	Methods Identification
Amino acids	Alk. hydrolysis-HPLC	AOAC 988.15 (modified) Tryptophan in Foods and Food and Feed Ingredients
	Performic oxidation-HPLC	AOAC 994.12 (4.1.11) (modified) Amino Acids in Feed (OPA post column)
	Acid Hydrolysis-HPLC	AOAC 982.30 (45.3.05) (modified) Protein Efficiency Ratio (Ninhydrin post column)
	Colorimetric	AOAC 990.26 (39.1.27) Hydroxyproline in Meat and Meat products
Fatty acids	GLC	CE 1-62 (1997) Fatty Acid Composition by Gas Chromatography
	GLC	AOCS Ce 1-62 for GC, and Ce 2-66 for prep of methyl esters
	GLC	AOAC 996.06 (41.1.28A) Fat (Total, Saturated and Monounsaturated) in Foods
	GLC	AOAC 996.06 (41.1.28A) Fat (Total, Saturated, and Unsaturated) in Foods & AOCS Ce 1c-89 Fatty Acid Composition by Gas Chromatography (modified)

Compile newly generated data to update the National Nutrient Databank

The acceptable data from the analytical laboratories are then combined with the descriptive information collected on the sample units and are migrated to NDL's Nutrient Databank System, which was designed with three levels (Initial, Aggregated, and Compiled) to manage and process food composition data (Haytowitz *et al*, 2009). In the Initial step, all the individual data points are maintained along with complete information on methods of analysis, analytical quality control, sample handling, common measures, component and refuse data, and the source and sampling information for each sample unit. Information is also retained on how individual sample units are composited. Values are converted to standard units of measure per 100 g, but the "as received" data values are also retained. In the Aggregated step, NDL scientists make decisions on how to group the data (e.g., combining data from different sources or a single source), weight the data (usually by market share or production information), and/or handle new data when data already exist for a food item (i.e., replace the old data or combine it with new data). Specialized statistical procedures are used to aggregate the groups of data and generate descriptive statistics which take into consideration the grouping and nature of the data. NDL scientists also use statistical procedures within the NDBS to compare sets of data and test for outliers. For food items used in the FNDDS, missing data are imputed according to scientific principles (Schakel *et al.,* 1998) at the Compiled step. Missing values can be calculated using the recipe or formulation modules within the databank system. These modules are based on linear regression and are often used to generate a few missing values for some foods and complete nutrient profiles for other foods. The formulation regression program uses nutrient values and ingredients (in a specified order) from product labels. The recipe program uses known amounts from authoritative sources to generate a specific food nutrient profile. Finally, the name of the food item is finalized, common measures are selected and ranked, and the item is approved for release. Prior to release, the data are sent to experts for review; brand name items are sent to food companies or appropriate trade associations, and other

foods are sent to analysts or other specialists familiar with the food and its nutrient content. The experts indicate if the data are acceptable based on their knowledge of the products and if any changes are recommended. If changes are made, the data are disseminated in annual releases of the SR database.

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Beef Products (Food Group 13)

Introduction

Data for beef products are presented in the USDA National Nutrient Database for Standard Reference. For most retail cuts, nutrient values are presented for cuts trimmed to 1/8-inch and 0-inch fat and for Choice or Select quality grades. Nutrient values reported as "All Grades" were estimated by combining the nutrient values for Choice and Select grades, weighted by their market proportions. A few Prime cuts trimmed at 1/8 inch external fat are also included.

The data in SR represent the amount of each constituent in 100 grams of edible portion. The edible portion in beef may be represented as "separable lean and fat" or as "separable lean only". In both cases, bone and connective tissue are removed from the cut and reported as refuse. In the case of "separable lean and fat", it is assumed that all fat present is consumed. For items described as "separable lean only", all external trim fat and seam fat are removed from the cut, weighed, and included in the reported refuse. Weights are determined for the whole retail cut as purchased, and for each component (e.g., separable lean, separable fat, refuse, etc.). Nutrient analyses are conducted on the separable lean and the separable fat. The external trim fat and the seam fat are combined for analyses and reported as separable fat. The nutrient values for separable lean and separable fat are weighted for their respective contributions to the whole retail cut and reported as "separable lean and fat". For cooked beef cuts, the cuts are cooked with the separable fat intact. Nutrient data for separable fat, separable lean only, and separable lean and fat of cooked cuts are analyzed or calculated as described above.

The analytical nutrient data include the mean nutrient value, the standard error given to three decimal places, and the number of observations on which the values are based. For many food items, mean values are given without an accompanying standard error and number of samples. These values are either calculated by pooling data by or by weighting means (e.g., All Grades), by applying cooking yields or nutrient retention factors, or by imputation from a different, closely related food. For raw beef items and unheated cured items, nutrient values are estimated on the known content of that nutrient in the lipid (fatty acids), total solids (cholesterol), moisture-free, fat-free solids (minerals), or protein (water-soluble vitamins) fraction of a similar food.

Nutrients

Nutrient information for SR can be found under "File Content" in the documentation. However, some nutrient information specific to beef products are included here. Nutrient data are obtained for moisture, protein, ash and total fat. The values for protein are calculated from the content of total nitrogen (N) in the food using the conversion factor recommended by Jones (Jones, D.B., 1941). The specific factor applied to beef items is 6.25. The carbohydrate content of uncured products (except some organ meats)

consisting entirely of beef is negligible. For such foods, the carbohydrate content is assigned a zero value. The sum of the percentages of water, protein, total lipid, and ash may not necessarily equal 100 percent for those foods showing zero carbohydrate because the amounts of each of these constituents are determined independently.

For heart, liver, kidney, tongue, and cured products (foods expected to contain carbohydrate), the carbohydrate value is calculated as the difference between 100 and the sum of the percentages of water, protein, total lipid, and ash. If the total of these constituents for any item is more than 100 due to analytical variation, the carbohydrate content is assigned a zero value.

Food energy is expressed in terms of both kilocalories and kilojoules. (One kilocalorie equals 4.184 kilojoules.) The data are for physiologic energy values remaining after losses due to digestion and metabolism have been deducted. Further discussions on energy and caloric factors used in SR can be found in the "Food Description File" of the general documentation.

The specific calorie factors used for calculating energy values in beef products are:

	Kcal/g
Protein	4.27
Fat	9.02
Carbohydrate	3.87

The carbohydrate factor of 3.87 is used for some organ meats and some cured products. The factor of 4.11 is used for tongue. The factors are based on the Atwater system for determining energy values. Details of the derivation of these factors are outlined in Agriculture Handbook No. 74 (Merrill, A.L. and Watt, B.K., 1973). Because the level of carbohydrate in separable lean and separable fat is insignificant, no carbohydrate factor is needed for most beef products.

Description of Projects

The studies documented in these notes on beef represent only data collected since 1998.

Selected cuts, 1/8 inch external trim fat.

A collaborative study was funded by the Beef Checkoff Program and conducted by USDA, America's Beef Producers, and Texas A&M University to determine the food and nutrient composition of 13 raw and cooked retail cuts for inclusion in the USDA National Nutrient Database for Standard Reference.

Sampling and fabrication. Carcasses (n=20) were selected from two packing plants, one in the Texas Panhandle and the other in Nebraska. Ten USDA Choice and ten USDA Select carcasses (yield grade 2 and 3) were selected for the study. These

carcasses represented the approximate distribution found in the US beef supply according to the National Quality Beef Audit – 1998 (Boleman, S.L. *et al*., 1998). All carcasses were shipped to Texas A&M University for fabrication of the following retail cuts: arm roast, bottom round roast, bottom round steak, brisket – flat half, eye of round roast, flank steak, round tip roast, small-end rib steak, tenderloin steak, tri-tip (bottom sirloin butt) roast (boneless and defatted), top loin steak, top round steak, and top sirloin steak. Cuts were assigned randomly to the following external fat trim levels: 0.0 cm (0 inch trim), 0.3 cm (1/8 inch trim), or 0.6 cm (1/4 inch trim). External fat was measured at five points, the points connected, and with a scalpel, the fat was removed half the thickness of the cut. This procedure was repeated on the other side, thus removing the excess fat completely. One additional steak was assigned to a raw treatment and trimmed to 0.3 cm. Three of the cuts (flank steak, round tip roast, and tri-tip roast) had no external fat and were therefore assigned to the 0.0 cm group for both preparations (raw and cooked). Dried surfaces, extending chine bones, minor muscles, and muscle pieces were trimmed from all cuts. All cuts were vacuum packed individually, labeled, and frozen at -23°C for further dissection and cooking. Additional details on fabrication have been previously published (Wahrmund-Wyle, J.L. *et al*., 2000).

Cooking procedures. (Wahrmund-Wyle, J.L. *et al*., 2000). Retail cuts destined for cooking were thawed overnight in a cooler at 5°C, weighed, and cooked as follows: arm roast, bottom round steak, and brisket were braised; bottom round roast, eye of round roast, round tip roast, and tri-tip roast were roasted; and flank steak, small-end rib steak, tenderloin steak, top loin steak, top round steak, and top sirloin steak were broiled.

For braising, cuts were browned for 4-8 min (time being size-dependent) in a preheated Farberware® Dutch Oven placed on top of a conventional range. After browning, the cuts were covered with 90-180ml distilled water, placed in a preheated conventional gas oven at 325°F (163°C) and simmered in a covered vessel to an internal temperature of 185°F (85°C).

Cuts for roasting were placed on wire racks with the fat side up, when possible, and cooked in a conventional gas oven (preheated to 325°F (163°C) to an internal temperature of 140°F (60°C). For broiling, cuts were cooked on electric Farberware® Open-Hearth Broilers (model 350A) to an internal temperature of 149°F (65°C). The internal temperature of each retail cut was monitored by inserting copper constantan thermocouples into the geometric center of the cut and recording the data on Honeywell recorders. After cooking, cuts were wrapped in plastic wrap and chilled (2-3°C) overnight (Jones, D.K. *et al*., 1992). Each cut was weighed prior to and after cooking for calculation of cooking yield.

Sample preparation. Individual samples from all cuts, both raw and cooked, were carefully dissected to separate and weigh the various cut components. These components included separable lean, external fat, seam fat, and waste such as bone and heavy (non-edible) connective tissue. The separable lean included muscle, intramuscular fat, and connective tissue that would be considered edible. External fat is the fat on the outside of the cut. Seam fat included intermuscular fat depots within the

cut. Separable fat from all cuts was pooled to form raw and cooked composites. Separable fat included both external and seam fat in these composites. Separable lean was placed in a Cuisinart® food processor and homogenized for 35 seconds. Sample aliquots were frozen at -10°C until analysis.

Sample analyses. Proximate nutrients (moisture, total fat, ash, and protein) were determined on individual samples and composites of the separable fat. Raw and cooked samples of separable fat and the separable lean from the arm roast, bottom round steak, and top loin steak, trimmed to 1/8 inch external fat, were also analyzed for minerals (calcium, copper, iron, magnesium, manganese, phosphorus, potassium, selenium, sodium, and, zinc) and vitamins (niacin, thiamin, riboflavin, vitamins B_6, and B_{12}). Samples from the raw and cooked arm roast and separable fat were analyzed for vitamins A and E, total folate, and pantothenic acid. Raw samples from the arm roast were analyzed for amino acids. Data were released in SR16 (2003).

Grass-fed Beef

A collaborative study (Leheska, J.M. *et al*., 2008) was funded by the Beef Checkoff Program and conducted by America's Beef Producers, Texas Tech University, and USDA to determine the nutrient composition of grass-fed beef in the United States for inclusion in SR. The demand for grass-fed products has increased in recent years due to increased public interest in grass-fed production practices and nutrition. Crop variety, season, and geographic location can have an effect on the nutrient content of feedstuffs. In turn, the different types of feed given to cattle can affect weight gain, carcass characteristics, and nutrient content.

Sampling. Ground beef and strip steaks were collected on 3 separate occasions from 15 producers of grass-fed beef, representing 13 different states (Alabama, Arkansas, California, Colorado, Georgia, Idaho, Kentucky, Minnesota, Missouri, Montana, New Mexico, Texas, and Virginia). The sample collection protocol required that 2 steaks from 3 different animals be collected by each producer on each of the 3 separate occasions. The steaks were cut 2.54 cm thick from the 13th rib position of the strip loin. Similarly, 454 g of ground beef targeting 85% lean and 15% fat was collected by each producer from 3 different carcasses on each of 3 different occasions. When the specified lean to fat ratio (85/15) was not available they were asked to provide the next leanest ground beef (e.g., 88/12). The samples were then packaged appropriately and shipped frozen to Texas Tech University.

Sample preparations, grass-fed ground beef samples. After the ground beef samples had thawed properly they were frozen in liquid nitrogen and homogenized. Once homogeneity was reached aliquots of the samples were double bagged in labeled Whirl-Pak bags and stored at -80°C until subsequent analysis.

Sample preparations grass-fed strip steak samples: After proper thawing, the strip steak samples were weighed and dissected. The lean, fat, and refuse (connective tissue and scrap) of each steak was separated and weighed individually. Samples of cubed

strip steak were frozen in liquid nitrogen and homogenized using the same protocol as ground beef samples. Aliquots of the homogenized samples were double bagged in labeled Whirl-Pak bags and stored at -80°C until subsequent analyses.

Chemical Analysis. Analyses of proximate nutrients were performed at Texas Tech University. Following ether extraction, fat was determined in each sample using the Soxhlet method according to Official Method 991.36. Percent protein was determined by combustion using a LECO FP 2000 following AOAC Official Method 992.15. Percent moisture of the samples was analyzed by oven drying according to AOAC Official Method 8.2.1.1 and percent ash was determined by difference. Fatty acid analysis and cholesterol content was performed by a commercial laboratory using gas chromatography according to AOAC Official Methods 963.22 and 994.15. The University of North Carolina analyzed the grass-fed beef samples for choline by extracting choline compounds and quantifying by liquid chromatography-electrospray ionization-isotope dilution mass spectrometry. Total choline content of the samples was calculated as the sum of choline-contributing metabolites. Total fat, thiamin, vitamin B_{12}, and minerals (calcium, copper, iron, magnesium, manganese, phosphorus, potassium, selenium, sodium, and, zinc) were analyzed by a commercial laboratory using AOAC Official Methods. To validate all analytical procedures, quality control was monitored by insertion of certified reference materials and blind duplicates into the sampling course. Data on Grass-fed beef was released with SR21 (2008).

Ground Beef Products.

The USDA, in collaboration with America's Beef Producers and the University of Wisconsin, undertook a study funded by the Beef Checkoff Program to update the nutrient composition data for ground beef products in SR. None of the ground beef products contained extenders. According to Federal regulations, ground beef has no added water, phosphates, binders, or extenders, and shall not contain more than 30 percent fat (USDA, FSIS, Code of Federal Regulations). Ground beef is a unique meat product in that a wide range of formulations for this product are available in most US retail stores. In order to provide consumers and industry with the nutrient composition information for this variable product, the study was designed to establish the mathematical relationship between the various nutrients and the total fat content of raw ground beef through regression techniques. The ultimate aim was to use these relationships for predicting the nutrient composition for raw and prepared ground beef.

Sampling. For the first phase of this study, ground beef samples for each of three fat categories (label declarations of <12% fat, 12-22% fat, or >22% fat) were purchased from 24 retail outlets nationwide. In this sampling plan developed for the NFNAP (Pehrsson, P.R. *et al*., 2000), the country was divided into 4 regions, with 3 consolidated metropolitan statistical areas (CMSA) within each region, with 2 retail stores selected within each CMSA. To obtain updated data at lower levels of fat reflecting current retail market trends, a second phase of the study was conducted, using the NFNAP sampling plan with 12 nationwide retail locations to procure additional ground beef products of various fat levels.

Sample preparation. Ground beef products were analyzed in raw and cooked form. To achieve uniform sizing for broiled and pan-broiled patties, 112 g of ground beef were pressed into a patty mold. Patties were broiled in a preheated conventional oven for 8.7 min (final internal temperature of 160°F (71°C). Pan-broiled patties were broiled in a pre-heated Westbend® electric skillet for 11.75 min (final internal temperature of 160°F (71°C). Patties were cut in half to evaluate degree of doneness based on color. Ground beef crumbles were cooked in a pre-heated Westbend® electric skillet for 5.3 min (final internal temperature of 160°F (71°C)), and drained in a colander. The loaf was baked in a conventional oven at 325°F (163°C) for 41 min (final internal temperature of 160°F (71°C)). No fat was added during cooking. After cooking, all samples were stored at –24°C in sealed vacuum bags until homogenization and analysis.

Sample analyses. Proximate nutrients (moisture, total fat, ash, and protein) and cholesterol were determined on individual muscle samples from the chuck clod, bottom round, and the knuckle, both raw and cooked. Two composites composed of up to four samples each were analyzed for fatty acids, B vitamins (niacin, thiamin, riboflavin, vitamins B6 and B12), and minerals (calcium, magnesium, potassium, manganese, iron, phosphorus, sodium, copper, zinc and selenium) for each muscle group. A single nationally representative composite composed of three samples was used for analysis of choline, total folate, vitamins E and K for each muscle group. Cooking yields were also calculated based on initial (raw) and final cooked weights from all samples. These data were disseminated in SR18 (2005).

Nutrient analyses were conducted at either University laboratories or at a commercial testing laboratory using AOAC methods. Quality control measures included duplicate sampling and the use of control composites and NIST certified reference materials (SRM 1546: Meat Homogenate).

Statistics. Data were analyzed using mixed model regression analysis to obtain a regression equation for each nutrient and preparation method (SAS, 2004). Nutrient values from the first phase of the study were released in SR15 (2002) for ground beef products containing 5%, 10%, 15%, 20%, 25%, and 30% fat. The ground beef SR items include values for raw samples, broiled patties, pan-broiled patties, pan-browned crumbles, and baked loaf. The nutrient data from the first phase were combined with the proximate data from the second phase. Recent data from another beef study provided data for estimating values for retinol, vitamin E (α tocopherol), vitamin D and *trans*-fatty acid. Updated regression equations for each nutrient and for each preparation method were calculated. Nutrient values were then estimated from the equations for updating SR for 30, 25, 20, 15, 10, and 5% fat, and new profiles were created for 3% and 7% fat ground beef for each preparation method. The ground beef calculator, released on the NDL website in 2006 and updated in 2014, computes the nutrient profile for raw and prepared ground beef products at lean/fat levels between 97/3 and 70/30.

Beef Value Cuts

A new line of single–muscle roasts and steaks, fabricated from the outside round, the knuckle, and the chuck shoulder clod, were introduced to the retail market in 2001-2002. These cuts, the top blade steak (Infraspinatus), shoulder top and center steaks (Triceps brachii), shoulder tender (Teres major), tip center (Rectus femoris), tip side (Vastus lateralis), and bottom round (Biceps femoris), were tested for palatability and functionality. Furthermore, five of the six major cuts met the USDA definition of lean or extra-lean. USDA, in collaboration with America's Beef Producers and the University of Wisconsin, conducted a study funded by the Beef Checkoff Program to determine the nutrient profile of the Beef Value Cuts for inclusion in SR.

Sampling. Animal products were obtained from an IBP (Tyson) plant near Sioux City, Iowa. This plant draws cattle from a large number of feedlots and has nationwide product distribution. Twelve carcasses were identified by quality grade (high choice, average choice, and select) with yield grades of 2 or 3. Two carcasses were used for reserves and for training the meat cutting staff. There was sufficient product from 1 knuckle, 1 outside round, and 1 chuck clod to sample, prepare, and analyze five of the cuts. The Teres major is a very small muscle (~8 oz from 1 side) and would not provide a sufficient amount for all analyses. Therefore, one 15 pound box of choice (quality grade unknown) and one box of select Teres major muscles were purchased from the same plant. Removed beef value muscles were trimmed free of all external fat and heavy connective tissue. The denuded muscles were vacuum packaged and stored at -20°F until steak preparation.

Sample preparation. Muscles were cut into 1-inch thick steaks and weighed. Steaks were removed in pairs, one steak for raw analyses, the other to be cooked and analyzed in the cooked state. Steaks were cooked by grilling over a preheated portable gas grill. Steaks were turned when the internal temperature reached the midway point between the starting temperature and the final internal temperature (including post-cooking temperature rise) of 160°F (71°C) (medium degree of doneness). Steaks were placed on a wire rack for 3 min and then weighed to obtain the cooked weight. Raw and cooked steaks were stored at -20°F (-29°C) until time for nutrient analyses.

Sample analyses. Proximate nutrients (moisture, total fat, ash, and protein) and cholesterol were determined on individual muscle samples from the chuck clod, bottom round, and the knuckle, both raw and cooked. Composites of three samples from each of these muscle groups were pooled into composites and analyzed for fatty acid content. Individual samples from the knuckle muscles were also analyzed for of minerals (calcium, copper, iron, magnesium, manganese, phosphorus, potassium, selenium, sodium, and, zinc) and vitamins (niacin, riboflavin, thiamin, vitamins B_6 and B_{12}). Samples from the raw and cooked knuckle muscles were also analyzed for vitamins A and E. No vitamins or minerals were analyzed on samples from the chuck clod or bottom round; NDL imputed these values based on nutrient values from the arm roast and bottom round. Cooking yields calculations were based on initial (raw) and final cooked weights from all samples. These data were disseminated in SR18 (2005).

Beef Nutrient Database Improvement Study:

A collaborative research study was undertaken by NDL with scientists at the National Cattlemen's Beef Association (NCBA), Colorado State University (CSU), Texas A & M University (TAMU), and Texas Tech University (TTU) to update nutrient information in the USDA National Nutrient Database for Standard Reference (SR). This entailed updating the food and nutrient composition for beef cuts currently in SR, and adding new cuts, which had been introduced in the market place. The first phase of this study involved cuts from the chuck: Brisket, Mock Tender Steaks, Top Blade Steaks, Shoulder Steaks Boneless, Shoulder Clod Roasts, Boneless Chuck Short Ribs, Denver Steaks, Chuck Eye Steaks, Country Style Ribs, America's Beef Roast, Underblade Steaks and Roasts, and Beef for Stewing. Most of these cuts are new with the exception of the Shoulder Steaks which replaced the older Clod Steak data (NDB#s 23533, 13943, 23536, 13946, 23554, 23516). The second phase of this study involved cuts from the rib and plate: Back Ribs, Rib Eye Roast, Rib Eye Steak, Outside Skirt, and Inside Skirt. During the second phase of the Beef Nutrient Database Improvement Study, a separate study on Beef Alternative Merchandising (BAM) beef cuts was also conducted. BAM cuts were developed by the beef industry to utilize all the potential meat from today's larger subprimals and traditional subprimals, and to respond to customers' desire for leaner, more health-conscious portions. BAM cuts are leaner and smaller than more traditional cuts. The boneless beef cuts added to SR from the BAM study were: Ribeye Filet, Ribeye Petite Roast, Ribeye Cap Steak, Top Loin Filet, Top Loin Petite Roast, Top Sirloin Filet, Top Sirloin Cap Steak, and Top Sirloin Petite Roast. In the third phase of this study, focusing on the loin and the round, these cuts were added to SR: Top Loin Steak trimmed to 0" fat, Top Loin Steak trimmed to 1/8" fat, T Bone Steak, Porterhouse Steak, Tenderloin Steak, Tenderloin Roast, Top Round Steak, Top Round Roast, Eye of Round Steak, and Eye of Round Roast. For each cut in this study, nutrient values are provided in SR in both raw and cooked forms for "separable lean only" and "separable lean and fat", and for quality grades Select, Choice, and "all grades". Data from this project were incorporated into SR and were also disseminated in a separate report on the NDL web site titled "USDA Nutrient Dataset for Beef Retail Cuts", revised periodically, with version 3.0 released in 2013.

Sampling: Beef carcasses for the study were selected from six different major packing plants, representing the different regions of the US Each university was assigned two different packing plants. The sampling plan was developed for 36 animals. In order to get true retention and yield data, an A and a B side of the animal carcass was needed; thus the total animal count came to 72. When selecting the carcasses certain properties were considered as part of the sampling plan protocol: quality grade (upper choice, lower choice, select), yield grade (YG2, YG3), gender (steer or heifer), and genetics (dairy or non-dairy). Each university was responsible for identifying and obtaining beef chucks that fit into the sampling matrix. The universities assessed and recorded carcass data at the packing plants, properly identified each selected cut and shipped the product back to their respective meat laboratories. Products were fabricated into the needed retail cuts for this study within 14-21 days postmortem.

Retail cuts were properly identified and vacuum packaged and held frozen until cooking or dissection. The retail product was cooked according to protocols developed for each cut. Cooked and raw products were dissected; weights for each component (separable lean, separable fat, and refuse) were obtained. Total weights of raw and cooked (prior to and after cooking) cuts were obtained. Samples were then homogenized and composited.

The compositing plan was developed to establish an effective and efficient statistical design for nutrient analyses of the beef cuts. The plan consisted of 4 different compositing levels: an animal level (36 animals) where all the samples were analyzed; a six composite level; a three composite level; and a national composite level. This was done for both raw and cooked samples. Different nutrients were analyzed at each composite level.

Sample preparation: The various beef cuts were analyzed in raw and cooked form. The following cooking methods were used: grilling, roasting, and oven-braising. Frozen raw samples were tempered under refrigeration (0-4°C) for 24 to 48 hours based on the appropriate size and weight of the cut. The appropriate temperatures and weights were recorded prior to cooking. The thermocouple was placed in the geometric center or thickest portion of the meat piece. The probe positioning did not affect the product's contact with the cooking surface. For small or thin beef cuts, the thermocouple was used periodically to check the internal temperature of samples throughout the cooking process.

Cooking Procedures:

Grilling - The grill was preheated to 195°C (383°F). The beef samples were evenly spaced in the center of cooking grate. The grill lid was closed and the sample was cooked to an internal temperature of 70°C (158°F). Tongs or spatulas were used to remove samples from the grill. Beef samples were allowed to stand while monitoring the internal temperature rise until temperatures began to decline. The point right before the temperature declines (highest temperature reached) was considered the final internal temperature of the cooked sample. Beef samples were then chilled uncovered in the refrigerator (2-4° C) for 24 ± 1 hour before dissection.

Roasting - The oven was preheated to 160°C (325°F). The beef sample(s) were positioned in the center of the rack in the roasting pan, no oil or water was added, and the pan was not covered. The roasting pan with the beef sample was positioned on the oven rack in center of oven and roasted to an internal temperature of 60°C (140°F). The beef samples were removed from the oven. The thermocouple probe remained in place and samples were allowed to stand while monitoring the internal temperature rise until temperatures began to decline. The point right before the temperature declines (highest temperature reached) was considered the final internal temperature of the cooked sample. The beef samples were then chilled uncovered in refrigeration (2-4° C) for 24 ± 1 hour before dissection.

Oven-Braising - The beef samples were placed in a preheated pan and were

"browned/seared", turning as needed for even browning on all sides. The pan drippings were poured off and the volume (mL) of drippings was measured. The thermocouple was then applied in the geometric center or thickest portion of the meat piece. A small amount of distilled, deionized water was added until the water reached one third-the thickness of the meat. The liquid was held at a simmer, the pan was covered with a lid, and placed in the Dutch oven. The Dutch oven was then placed in a preheated 120°C (250°F) oven. The beef samples simmered and cooked until an internal temperature of 85°C was reached. The samples were removed from the oven keeping the thermocouple probe in place and were allowed to stand while monitoring the internal temperature rise until temperatures began to decline. The point right before the temperature declines (highest temperature reached) was considered the final internal temperature of the cooked sample. The beef sample(s) were removed from the cooking liquid and the cooking liquid yield and volume were documented. The beef samples were then chilled uncovered in the refrigerator (2-4° C) for 24 ± 1 hour before dissection. In phase two, the back ribs were oven-braised and the "browned/seared" step was not performed.

Nutrient Analysis: At the animal level, only proximates were analyzed. At the next level, the six composite level, the following nutrients were analyzed: Proximates (fat, moisture, protein, and ash), fatty acids including long-chain fatty acids and CLAs, total cholesterol, minerals (Ca, Fe, Mg, P, K, Na, Zn, Cu and Mn), selenium, vitamin E, vitamin D, and B vitamins including B12, B6, riboflavin, and niacin. At the 3 composite level, amino acids and retinol were analyzed. At the final National composite level, total choline and the other B vitamins (thiamin and pantothenic acid) were analyzed. The pooled fat samples, both raw and cooked, from all the cuts were analyzed for all nutrients.

The techniques for analyzing the proximate nutrients are as follows: Protein by combustion, total fat by extraction and acid hydrolysis, ash by gravimetric, and moisture by forced air. The minerals calcium, magnesium, iron, zinc, copper, and manganese were analyzed by atomic absorption spectroscopy (AAS). Potassium and sodium were analyzed by emission spectrometry, and selenium by hydride generation. Retinol, vitamin E, and vitamin D were analyzed by high-performance liquid chromatography (HPLC) methods. Choline was analyzed by liquid chromatography-electrospray ionization-isotope dilution mass spectrometry (LC/ESI/IDMS). B-vitamins such as thiamin and riboflavin were analyzed by fluorometric methods. Niacin, pantothenic acid, vitamin B6, and vitamin B12 were analyzed by microbiological methods. Amino acids such as tryptophan were analyzed by alkaline hydrolysis-HPLC, cystine and methionine by performic oxidation-HPLC, and all other amino acids by acid hydrolysis-HPLC. Hydroxyproline was analyzed using a colorimetric method, cholesterol by a gas chromatographic (GC)/direct saponification method not using derivatization, and fatty acids by gas-liquid chromatography(GLC).

New Zealand Beef Study

A study was conducted in collaboration with the New Zealand Meat Industry Association to determine nutrient composition of 32 imported New Zealand beef cuts and offal items (10 samples per cut) which are available in retail grocery stores in the US. This study was done along with study of New Zealand lamb cuts, described in the Notes on Lamb section of this report. The beef cuts were bolar blade, brisket naval end, brisket point end, chuck eye roll, cube roll, eye round, flank, flat, hind shin, inside cap-off, oyster blade, ribs, rump center, strip loin, tenderloin, heart, tongue, tripe, kidney, knuckle and liver. These cuts were selected by the members of the New Zealand Meat Industry Association with different items being supplied from different meat plants throughout New Zealand. Retail cuts fabricated from the meat carcasses were prepared for dissection, homogenization and nutrient analysis at Massey University, New Zealand. Weights for component factors such as separable lean, intramuscular and subcutaneous fat (separable fat), bone and connective tissue were determined. Nutrient values were added to SR for each of these cuts in both raw and cooked form (using a braised, fast roasted, fast fried, or boiled method) for “separable lean only” and “separable lean and fat“ items.

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Breakfast Cereals (Food Group 08)

Introduction

Food Group 08 foods are identified as breakfast cereals to clearly distinguish them from cereal products used mainly as ingredients or typically consumed at meals other than breakfast (see Food Group 20 Cereal Grains and Pasta). The Breakfast Cereals group of more than 360 items includes two major categories: ready-to-eat (RTE) and to-be-cooked (hot) cereals. The majority of breakfast cereals are listed by brand name. The number and level of fortification nutrients differ appreciably between breakfast cereals, resulting in many unique products that can't adequately be described generically. The majority of major brand breakfast cereals are included in SR, accounting for over 80% of the retail market.

Breakfast cereals generally consist of one or more cereal grains, either as whole grains or milled portions, as a major constituent. The continuum of grain content goes from less than 50% for some presweetened RTE cereals and approaches 100% for hot cereals. The predominant grains for RTE cereals are corn, wheat, oats and rice. Additional ingredients such as sweeteners, flavoring or texturizing macroingredients (including fruit, nuts, and oil), microingredient flavors or colors, and nutritional fortificants and shelf life preservatives may be added (Caldwell, 2000). Manufacturing processes generally used for RTE cereals include: flaked, extruded flakes, gun-puffed whole grains, extruded gun-puffed, oven-puffed, shredded whole grains, and extruded shredded methods.

Fortification: Addition of vitamins and/or minerals to grain products began in the late 1930's with selected nutrients (primarily thiamin, riboflavin, niacin, iron, and calcium) being added in amounts to restore the natural content of the grain which may have been modified during processing (enrichment). A standard of identity, effective in 1942, established standards for unenriched and enriched farina. Enrichment standards were developed for corn grits in 1947 (Park, 2001; FDA 2012). In 1955, nutrients were first added to breakfast cereals in amounts higher than those of the whole grain itself. By 1969 many RTE cereals were fortified with 25% of the US RDA for thiamin, riboflavin, niacin, vitamin B6, vitamin B12, A, C, and folic acid; with iron at 10 to 25% RDA; and some cereals with vitamin D at 10% RDA (Steele, 1976). A recognition of the importance of folate in prevention of neural tube defects led to an FDA regulation, effective in 1998, requiring folate fortification of specific flours and grains (see Table of Standards of Enrichment, in Notes on Foods for Cereal Grains and Pasta), including enriched farina, which is used as a hot cereal (Phillips, 2010; Rader, 2000). Ready-to-eat cereals were not affected by the regulation. Today, nearly all processed ready-to-eat breakfast cereals are fortified with vitamins and/or minerals at varying levels.

Addition of nutrients presents technological problems – some vitamins are not heat stable; others are affected by pressure; and some can produce undesirable tastes and odors (Steele, 1976). Incorporation of fortificants before processing provides uniform

distribution of the nutrients, but may lead to undesirable loss of nutrients and flavor changes. Thus, some cereals are exposed to multiple coating processes for topical application of the added nutrients. A phase 1 coating may include vitamin addition, then phase 2 may include coating with slurries of sugars, honey and flavoring agents. Coatings may be applied by spraying the product as it passes down a conveyer belt or may be added by means of a coating drum (Burns, 2000). Manufacturers generally add nutrients at a higher level than labeled to compensate for possible losses during processing, thus ensuring that content of fortification nutrients in the packaged cereal meets or exceeds the declared level (FDA, 2010).

Nutrient data: Due to the frequency of reformulations of breakfast cereals and brand name specificity of most items in this food group, the Nutrient Data Laboratory relies heavily on the cereal industry to provide current nutrient data for breakfast cereals in SR. Kellogg and General Mills, who represent nearly two-thirds of the RTE retail market (Schroeder, 2011), typically supply data each year, while Quaker, Post, and others contribute data some years. Breakfast cereal manufacturers generally can provide data for proximates, all fortification vitamins and minerals and some non-fortification vitamins and minerals. Data for fatty acid classes (total saturated, monounsaturated and polyunsaturated fatty acids) are generally provided, but individual fatty acids rarely so. Industry-provided fortification nutrient values are based on the label-declared values, representing the minimum amount of that fortified nutrient that should be present in the cereal. Although industry does not provide values for all non-fortification vitamins and minerals, a portion of these nutrients (e.g., magnesium and vitamin C) are generally industry-supplied. Some nutrient values are derived from the product's nutrition facts label, as well.

Every few years, beginning in 2002, various RTE cereals with a high market share have been selected for statistically representative nationwide sampling and nutrient analysis as part of the USDA National Food and Nutrient Analysis Program (NFNAP). Hot cereals, such as regular and instant oatmeal, corn grits, and farina, were sampled through NFNAP, as well. The NFNAP sampling method is described in detail elsewhere (p. 52). The most recent sampling in 2013 was for Quaker and private label maple brown sugar instant oatmeal, General Mills Honey Nut Cheerios and Cinnamon Toast Crunch.

Approximately 200 breakfast cereals are included in a subset of foods supplied for the Food and Nutrient Database for Dietary Studies, which is used for national nutrition monitoring. For these products, there is a list of 65 nutrients for which values must be provided. A variety of standard imputing methods are available in NDL's databank system for estimating missing nutrient values. The predominant imputation method for RTE cereals is by NDL's formulation estimation procedures. These estimation procedures were incorporated into the databank system; they include linear programming techniques to estimate ingredient proportions by weight and calculate a full nutrient profile based on this estimated commercial recipe (i.e. formulation) (Haytowitz, 2009). Individual fatty acids, choline, vitamin K, carotenoids, caffeine and theobromine are generally derived by the formulation method. In the absence of

analytical data, added folic acid is calculated by subtracting estimated natural food folate from the total folate value provided by the manufacturer.

In general, a profile is calculated by recipe for the cooked version of hot cereals that are sold in bulk, such as rolled oats or farina. The yield and retention factors are applied to the recipe to estimate the effects of cooking on moisture and nutrient levels.

Food Group 08 items in SR include data for both ready-to-eat and hot breakfast cereals that are derived from cereal manufacturers, food labels, lab analyses, formulation and other estimations. Recent trends show a decrease in sugar and sodium levels and increase in fiber levels in RTE cereals, on average (Thomas, 2013). NDL will continue to monitor these and other changes.

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Cereal Grains and Pasta (Food Group 20)

There are over 180 food items in the Cereal Grains and Pasta food group in the SR. The sources of nutrient data for these items are mainly analytical obtained from the scientific literature or analytical studies. These include data collected by nationwide sampling under NDL's NFNAP program, described earlier.

Federal Definitions and Standards of Identity have been published for a number of cereal grain and pasta products appearing on the market today (FDA, 2008a, 2008b). Federal Enrichment Standards exist for wheat flour, cornmeal, rice, and macaroni and noodle products (FDA, 2008a, 2008b). These standards do not mandate the enrichment of the products, but if it is labeled as "enriched," specified nutrient levels must be present. Federal standards specify enrichment levels or ranges for thiamin, riboflavin, niacin, iron, and folic acid in most enriched products. The Federal Enrichment Standard for riboflavin in enriched rice has been stayed since 1958, and hence riboflavin is not currently added to enriched rice. The standards for enriched grain products were amended to require the addition of folic acid beginning in 1998. Addition of calcium to most enriched products is optional, but if added must meet specified levels. However, consistency in levels of enrichment may be an issue (Guerrero et al, 2009). The current Federal Enrichment Standards are listed in Table 21.

In the Cereal Grains and Pasta food group, data are presented for the enriched and unenriched forms of commonly enriched products.

Table 21. Standards for Enrichment[1]

Food Item	Thiamin	Riboflavin	Niacin	Iron	Folic Acid	Calcium[2]
	--- milligrams per pound ---					
Wheat flour	2.9	1.8	24	20	0.7	960
Self-rising wheat flour	2.9	1.8	24	20	0.7	960
Cornmeal	2.0-3.0	1.2-1.8	16-24	13-26	0.7-1.0	500-750
Self-rising cornmeal	2.0-3.0	1.2-1.8	16-24	13-26	0.7-1.0	500-750
Rice	2.0-4.0	1.2-2.4[3]	16-32	13-16.5	0.7-1.4	500-1,000
Macaroni and noodle products	4.0-5.0	1.7-2.2	27-34	13-16.5	0.9-1.2	500-625

1. A range of figures indicates minimum and maximum levels. A single figure is the minimum level, with overages left to good manufacturing practice.
2. Calcium enrichment is optional in these products.
3. The enrichment standard for riboflavin in enriched rice has been stayed since 1958.

In 2010, the US Departments of Agriculture and Health and Human Services released the seventh edition of the Dietary Guidelines for Americans, which set evidence-based

recommendations for the public to help prevent disease (US Departments of Agriculture and Health and Human Services, 2010). The guidelines emphasize consumption of whole grain foods, stating at least half of an individual's recommended total grain intake should be whole grains to reduce the risk of several chronic diseases and help with weight maintenance.

The AACC International definition of whole grains is "Whole grains shall consist of the intact, ground, cracked or flaked caryopsis, whose principal anatomical components - the starchy endosperm, germ and bran - are present in the same relative proportions as they exist in the intact caryopsis."

In 2006, FDA issued draft guidance for Industry and FDA Staff on Whole Grain Label Statements. It can be accessed at: http://www.fda.gov/Food/GuidanceComplianceRegulatory Information/GuidanceDocuments/FoodLabelingNutrition/ucm059088.htm.

Cereal grains.—The majority of the cereal grains included in Food Group 20 are cultivated grasses belonging to the Poaceae (alt.Gramineae) family and are thus true cereals. Amaranth, buckwheat, and quinoa differ botanically from true cereals, and are referred to as pseudo cereals because they are grown and used like cereal grains (Brouk, 1975). Arrowroot flour is derived from arrowroot and tapioca is produced from cassava root, which are both non-cereal-grain plants, but used in ways similar to cereal grains.

The scientific name is given for the most unprocessed form of the cereal grain in the database. The Germplasm Resources Information Network (GRIN) was used as the basic reference for the scientific names and preferred common names (USDA, 2011).

With the exception of corn (maize), which is native to the Americas, nearly all true cereal grains originated in Europe and Asia (Brouk, 1975). Buckwheat is native to central Asia. Amaranth and quinoa are native to Central and South America, respectively.

Kasha, a buckwheat product, originated in Russia. Buckwheat groats, which are roasted to develop a distinctive nutty flavor, may be packaged in the whole form or milled to either coarse, medium, or fine granulations. Kasha is usually cooked as a hot cereal or prepared in combination with other foods and ingredients.

Corn and corn products appearing in Food Group 20 are restricted to field corn varieties and do not represent the varieties (sweet corn) used mainly as a vegetable. Corn and cornmeal products are available in white, yellow, and blue varieties. Yellow corn varieties have higher vitamin A values due to the presence of the provitamin-A carotenoids, alpha- and beta-carotene. Yellow corn also has much higher levels of lutein + zeaxanthin. With the exception of these nutrients, the composition profiles of white and yellow corn are similar.

Self-rising cornmeals and wheat flours have more calcium, phosphorus, and sodium due to the addition of chemical leavening agents and salt. Sodium bicarbonate, monocalcium phosphate, sodium acid pyrophosphate, and sodium aluminum phosphate are the most commonly used leavening agents. Salt is also usually added to self-rising products for flavor. Bolted cornmeal has had most of the bran removed during milling, but contains most of the germ present in the whole-grain corn.

Masa corn flour is milled from corn which has been steeped in a lime (calcium hydroxide) solution. This is done both to facilitate the removal of the outer hull of the corn grain and to impart the characteristic flavor of authentic corn tortillas and other related products. As a result of the use of lime in processing, masa corn flour is higher in calcium than other corn products.

Brown rice has the bran layers intact. Rice that has been milled to remove the bran layers is referred to as white rice in this database.

Bulgur, a wheat product, has been produced in the Middle East and northern Africa since ancient times. Bulgur is produced by parboiling, drying, and then cracking wheat kernels. It is usually consumed as a cooked cereal or as an ingredient in other dishes.

Couscous is coarse-ground wheat endosperm made from durum wheat or another hard wheat variety. Couscous is a popular food in northern Africa and in the Middle East. It is usually eaten as a hot cereal or combined with other foods.

Wheat flour tortilla mix is used for making flour tortillas and other related products. This product is higher in calcium than other wheat flour products because calcium carbonate is added.

Bread flour, approximately 13% protein, is milled primarily from hard wheats. Cake flour, approximately 9% protein, is milled from soft wheats. Semolina is coarse-ground endosperm from durum wheat, and is used chiefly for making pasta.

Teff is an ancient crop believed to have been domesticated in the northern highlands of Ethiopia. It is used alone or in combination with sorghum to prepare the fermented flat bread, injera (Dendy, 1995).

Corn grits, farina, rolled oats or oatmeal, and toasted wheat germ are included in Food Group 08, Breakfast Cereals.

Nutrient data for different forms and products of each cereal grain were not obtained from the same sample or source. For example, a single source of wheat was not processed to all forms given in the database: whole-grain, bran, germ, and various flour products. The data were obtained from many sources at different times for analysis and are affected by different variables: growing locations, crop years, cultivars, natural variability, milling and processing techniques, laboratories, and possibly methods of analysis. Therefore, in a comparison of different forms and products of a cereal grain,

nutritional differences may not measure precisely the effect of processing or preparation methods.

Pasta.—Under Federal Standards of Identity, there are two broad categories of pasta products: macaroni and noodle products (FDA, 2008b). Macaroni products are formed by extrusion of the pasta dough into a variety of shapes and sizes including elbows, spirals, shells, twists, wheels, etc. Specific shapes of macaroni products have unique names such as rigatoni, manicotti, ziti, linguini, and spaghetti which are recognized by the consumer.

Although spaghetti is defined under Federal standards as a macaroni product, it is included as a separate category due to its unique market identity. However, the nutrient composition of spaghetti and that of other forms of macaroni products are the same on an equal weight basis.

Noodle products are also available in a variety of sizes and shapes. Federal Standards of Identity specify that noodle products must contain not less than 5.5 percent by weight of the solids of egg or egg yolk (FDA, 2008b).

Various forms of vegetable macaroni and noodle products are available today. Federal standards specify that these products must contain a minimum of 3 percent by weight of the solids of tomatoes (red varieties), artichoke, beet, carrot, parsley, or spinach ((FDA, 2008b). Spinach noodles and tricolor-type (red, green, and regular) macaroni are the most commonly available products of this type on the market.

Protein-fortified macaroni products, both with and without added vegetable solids, are also available. These products usually contain wheat germ, dried yeast, or other ingredients which increase the protein content of the product. If a macaroni product is labeled as “with Fortified Protein,” under Federal standards it must have a protein content of at least 20 percent on a 13-percent moisture basis and protein quality not less than 95 percent of that of casein (FDA, 2008b).

Corn pasta is available on the market to meet the needs of those who are allergic to wheat and hence must avoid foods containing wheat ingredients. Corn pasta is made exclusively from corn flour. Since it contains no wheat flour ingredients, corn pasta is not required to meet Federal standards for macaroni or noodle products.

Fresh-refrigerated pasta has a higher moisture content than dry pasta and must be kept under refrigeration until prepared. Data are presented for plain and spinach types, both of which contain egg. Stuffed pasta such as ravioli and tortellini are listed in Food Group 22, Meals, Entrees, and Side Dishes.

Data are presented for the cooked forms of both egg-containing and non-egg-containing homemade pasta. The recipe used for each item is footnoted.

Oriental noodles do not fall under Federal Standards of Identity. Although these products may be labeled as noodles, they usually do not contain eggs. Chinese-style pasta products currently in SR include rice noodles, chow mein noodles, and fried flat noodles. Two Japanese noodles are currently in SR: soba noodles are made with buckwheat flour; somen is a thin wheat flour noodle. Chinese cellophane noodles, also called long rice noodles, are made from mung bean flour and are included in Food Group 16, Legumes and Legume Products.

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Eggs (Food Group 01)

Recently, NDL arranged to have regular large, whole eggs picked up in a nationwide sampling as part of NFNAP. Notes on other food items in this food group will be included at a later time.

Sampling and analysis. Whole egg samples of regular large eggs were picked up in March/April 2010 at the 12 NFNAP sampling locations. The sample units were sent to the Food Analysis Laboratory Control Center (FALCC) at Virginia Tech for preparation of analytical samples to be sent to the qualified analytical laboratories. Individual samples from each of the 12 locations were prepared for the determination of proximates (moisture, protein and fat), fatty acids, and cholesterol. Samples units from the 12 locations were paired, using randomization, to create six city-pair analytical composites for analysis of vitamins, minerals, and sugars. FALCC also sent quality control (QC) samples to the analytical laboratories to monitor accuracy and precision of measurements.

Results. The analytical and QC data received from the analytical laboratories were reviewed. The QC results were found to be acceptable, and the analytical data for most nutrients were comparable to the current data in the National Nutrient Database for Standard Reference, Release 22 (SR22). Values for cholesterol, vitamin D, and vitamin B_{12} were significantly different from the older values which were based on analyses from eggs sampled in 2002.

Cholesterol was determined by gas chromatography; the new value for cholesterol is 372 mg/100g compared to the SR22 value of 423 mg/100g. This estimate was based on the analysis of the 12 individual samples by each of three independent qualified laboratories. The results for QC materials from all three laboratories were also acceptable.

Vitamin D was determined by HPLC-UV for the six city-pair composites. The results for the QC material were within the acceptable range. Two of the city-pair composites were analyzed by another lab using HPLC-MS/MS to double check the data. The inter-lab results were in good agreement.

Values for four of the six city-pair composites for Vitamin D averaged 1.2 µg (49.2 IU)/100g (with a range of 1 µg (39 IU) – 1.8 µg (71 IU)/100g), compared to the SR22 value of 1.2 µg (49.6 IU)/100g. However, the values for the other two city-pairs were 3.8 µg (150 IU)/100g and 8.7 µg (348 IU)/100g. Each city-pair with a higher vitamin D value contained samples of eggs for a specific brand picked up in two non-contiguous states from the same grocery store chain, and those cartons were labeled as follows: 5X MORE VITAMIN D PER EGG.

Reserve samples for the four individual cities that were part of the two city-pairs with higher vitamin D were sent to the laboratory to be analyzed for vitamin D. One of the city values was within the expected range (1 µg (39 IU) – 1.8 µg (71 IU)/100g) of the

data for the current estimate. The other three city values were much higher and fell between 7.1 µg (284 IU)/100g and 12.1 µg (483 IU)/100g. Two of these three samples were from the same store brand, and their respective cartons were labeled as indicated above, and thus higher in vitamin D. The third of the three was obtained from a store brand that had no vitamin D statement on the carton. Additional samples of that brand were sampled, analyzed, and confirmed.

To calculate the final estimate of vitamin D in large, whole eggs, all values from samples which had no vitamin D claims were averaged together to yield a value of 2.0 µg (82 IU)/100g with a range of 1.0 µg (39 IU)/100g to 9.2 µg (368 IU)/100g. The new value is 64% higher than the SR22 value of 1.2 µg (50 IU)/100g.

The values for the store brand which contained a vitamin D claim were not used. NDL staff decided that the presence of a claim could influence the selection of that brand by the consumer and may bias the representativeness of the sample set. However, it is clear that some eggs in the marketplace now contain higher levels of vitamin D. It is likely that this change is due to the fortification of specific feeds given to the laying hens. More research will be needed to assess the impact on vitamin D levels in eggs nationwide.

The new value for vitamin B_{12} (0.89 µg/100g) is 31% lower than the value in SR22 (1.29 µg/100g). The values for the QC samples were satisfactory.

Impact. All egg products that contain egg yolk, where the fat soluble cholesterol and vitamin D are found, were updated to reflect the change in values. NDL food specialists, who use whole eggs and other egg products as ingredients in formulations and recipes, will use these cholesterol and vitamin D values to calculate the composition of those food items. NDL plans to follow up on the sampling and analysis of whole eggs in one to two years to monitor levels of vitamin D in samples nationwide.

Lamb, Veal, and Game Products (Food Group 17)

Recently, NDL collaborated with other scientists to obtain analytical data on Australian lamb and veal, as well as New Zealand lamb. NDL also collaborated with Colorado State University on a domestic veal study. Notes on other items in this food group will be included after other studies have been completed.

Australian Lamb and Veal Study

A study was conducted to obtain nutrient values for specific cuts of raw Australian veal and lamb. Australian scientific collaborators sent samples to Texas Tech University, where samples were homogenized, composited, and analyzed for nutrients needed for labeling. The veal cuts analyzed were rib roast, fore shank, and hind shank. Ground lamb sold as 85% lean was also analyzed. Nutrient values were added to SR for each of these cuts.

New Zealand Lamb Study

A study was conducted in collaboration with the New Zealand Meat Industry Association to determine nutrient composition of 25 lamb cuts and offal items (8-10 samples per cut) which are available in retail grocery stores in the US. This study was done along with a study of New Zealand beef cuts, described in the Notes on Beef section of this report. The lamb cuts were boneless chump, hind shank, tunnel boned leg/ chump off/shank off, bone in leg chop/steak, fully frenched rack, partly frenched rack, tenderloin, boneless loin, loin chop, loin saddle, square cut shoulder, boneless rolled netted shoulder, square cut shoulder chops, foreshank, breast, boneless flap, neck chops, ground lamb, liver, kidney, heart, sweetbreads, brains, testes, and swiss cut tongue. These cuts were selected by the members of the New Zealand Meat Industry Association with different items being supplied from different meat plants throughout New Zealand. Retail cuts fabricated from the meat carcasses were prepared for dissection, homogenization and nutrient analysis at Massey University, New Zealand. Weights for component factors such as separable lean, intramuscular and subcutaneous fat (separable fat), bone and connective tissue were determined. Nutrient values were added to SR for each of these cuts in both raw and cooked form (using a braised, fast roasted, fast fried, or boiled method) for “separable lean only” and “separable lean and fat” items.

Retail Veal Study

A study was conducted with Colorado State University (CSU) to obtain nutrient and composition data for 7 representative retail veal cuts. The cuts were: loin chops, loin roast, shoulder blade chops, foreshank (center cut), foreshank (osso buco), cutlets, and ground veal. These retail cuts were obtained from the six major US establishments which conduct their own slaughter of special fed (non-bob veal) US calves. The locations were Greeley CO, Collingswood NJ, Detroit MI, Harleysville PA, Franklin WI, and Vineland NJ. Raw and cooked samples (n=6 per cut) were dissected using

standard protocols and then homogenized, composited, and analyzed at CSU for proximates, fatty acids, cholesterol, and ICP minerals. The B-vitamins, vitamins D3 and 25(OH)D, and selenium were analyzed at a validated commercial laboratory. Choline and vitamin E were analyzed at specialized laboratories. Weights of component factors for each cut, such as separable lean, separable fat, and bone and connective tissue, were determined. Nutrient values were added to SR for these cuts in raw and cooked form (grilled, braised or pan-fried) for “separable lean only” and “separable lean and fat”.

Legumes and Legume Products (Food Group 16)

The legumes included in this food group are restricted to the mature, dry seeds of the family Fabaceae or Leguminosae, as well as products made from them. The immature seeds or pods and other parts of the plant, such as leaves, tubers, and sprouted seeds are included in Food Group 11, Vegetables and Vegetable Products.

The sources of nutrient data include the scientific literature, analytical studies conducted by NDL and other government agencies, and the food industry. Since the inception of NFNAP (p. 52) in 1997, a few legumes and legume products (common beans, baked beans, refried beans, chickpeas, peanut butter, and tofu,) have been sampled and analyzed. Data for commonly consumed raw and cooked legumes were obtained by a comprehensive study conducted in the 1980's at the University of Idaho. Data on other raw and cooked legumes, for the most part, have been obtained from the scientific literature. In most cases, data for other processed legumes were supplied by the food industry or obtained from the scientific literature.

Data are presented for raw, cooked, and canned legumes. Legume products, such as peanut butter, soy milk, soy flour, isolates and concentrates, tofu, tempeh, and natto, are also included in this food group. If appropriate, data are presented for both the unprepared and the prepared forms of the food.

Nutrient data for different forms of the same legumes and the legume products were not necessarily derived from the same sample. That is, a single sample of kidney beans was not analyzed in all forms given in the database: raw, cooked, and canned. The data were obtained from many sources and most likely represent different crop years, growing areas, cultivars, processing techniques, lengths and conditions of storage, and possibly different methods of analysis. Therefore, in a comparison of different forms of a legume, nutritional differences should not be ascribed solely to the effect of processing or preparation methods.

Raw legumes.--Although nutrient data were available for several cultivars of some legumes, the data base for any one cultivar was too small to justify giving separate entries by cultivar. Mature legumes are not eaten raw because toxic factors, such as hemaglutinins and trypsin inhibitors (Akroyd and Doughty, 1982), are present. Raw, mature legumes are also unpalatable and hard to digest. The usual processing or preparation methods, such as cooking and canning, remove or inactivate these toxic factors. Cooking or other processing of legumes also makes them more palatable by reducing the beany flavor that some find objectionable.

Prepared legumes.--Nutrient data for cooked legumes were sometimes unavailable or incomplete. In these cases, nutrient values for the cooked form were calculated from data for the raw form of the same legume. For example, nutrient data for boiled peanuts were calculated from data for raw peanuts.

Appropriate true nutrient retention factors were used to calculate the nutrient content of the cooked foods after adjusting for moisture changes. These are presented in the USDA Table of Nutrient Retention Factors, Release 6 (2007). The percentage yields for cooked legumes prepared from raw legumes are given in Table 22. The increased moisture content for cooked legumes leads to the average yield factor of about 2.5.

Table 22. Yields Factors for Selected Cooked Legumes

Legume	Yield Factor Ratio of Weights[1]
Beans:	
Black	2.3
Cranberry	2.3
Great northern	2.5
Navy	2.3
Pink	2.3
Pinto	2.4
Red kidney	2.4
Small red	2.3
Small white	2.3
Broadbeans	2.8
Chickpeas	2.1
Cowpeas	2.6
Lima beans:	
Baby	2.4
Large	2.6
Lentils	2.7
Mung beans	3.2
Peas, split	2.5
Pigeon peas	2.6

[1] Ratio of Weights = (Weight of legume cooked / Weight of legume, uncooked)

Sodium values for cooked legumes are relatively low because no salt was added. Since the sodium content of tap water varies according to location (0-39 mg/100g [NDB No. 14429]), the sodium value of cooked legumes may be underestimated if the water supply naturally contains significant amounts of sodium. Sodium content of cooked legumes will depend on the amount of salt used in cooking and can be as high as that of canned legumes. Sodium values for cooked legumes with added salt were calculated by adding the sodium content of approximately 1/8 of a teaspoon of salt per 100 grams of legumes or 236 mg of sodium to the sodium naturally occurring in the cooked vegetable with no salt added. Tap water also contains other dissolved minerals. The content varies considerably depending on the source and treatment of the local water supply.

Retention values are generally based on cooking methods that minimize the loss of nutrients, particularly the water-soluble vitamins, primarily due to leaching into the cooking water. Nutrient values of cooked legumes obtained by these procedures tend to be higher than those values for the same legumes cooked by less-than-optimum methods. Some conditions that affect the retention of nutrients in legumes include cooking method, size and shape of the legumes or amount of surface area, maturity, condition of the legume, proportion of broken seeds, amount of cooling water and cooking time.

Nutrient values for multi-ingredient mixtures such as home-prepared Boston baked beans were calculated from recipes developed by the US Department of Agriculture. Values for each nutrient provided by the ingredients used in the recipe were totaled. Nutrient values were adjusted by using appropriate nutrient retention values to account for any changes caused by evaporation or hydration and heat destruction due to cooking procedures.

Data for canned legumes were often developed for the purpose of nutritional labeling; therefore data are presented for the total can contents. During the canning process, and sometimes during cooking, the cotyledons of legumes rupture, releasing starch into the brine; therefore, draining of the liquid medium is difficult. However, cooks do generally drain these products. Some packers may add sugar to certain canned legumes and this may also affect the nutrient content.

Nomenclature.--To aid in identifying individual legumes listed in the tables, the scientific name of the legume is included in the food description file, usually on the raw form of the legume. The USDA Germplasm Resources Information Network (GRIN), (USDA, 2011) was used as the basic reference for the scientific and preferred common names.

Identifying legumes by their common names, however, is often confusing because these names are not always applied to the same food in different geographical locations. Some names of legumes in common use or unique to one region of the country have been included in the common name filed of the food description file. Additional descriptions of legumes and legume products are provided in the following paragraphs.

In other countries and among immigrants to the United States, various terms are often substituted for “legume.” The term “pulse” is sometimes used for a legume having a low fat content. Pulses include common beans, broadbeans, peas, and lentils. Soybeans and peanuts are sometimes referred to as leguminous oilseeds (Akroyd and Doughty, 1982). Data on oils derived from these sources, are found in Food Group 4, Fats and Oils.

“Dhal” or “dal” are legumes that have been dehulled and split. This practice is common in India to shorten the cooking time. “Gram” is a term sometimes used in India for the whole seed of any legume (Yamaguchi, 1983) and sometimes used as another name

for the chickpea (Duke, 1981). There are a number of other "grams." For example, red gram refers to pigeon peas, green gram to mung beans, and Bengal gram to chickpeas.

Adzuki beans (*Vigna angularis*) are grown primarily in East Asia, but have been introduced into the southern United States and Hawaii. These beans are eaten either boiled or fried. Adzuki beans ground into a fine paste are used in some confections, such as yokan. Canned adzuki beans, sweetened with sugar, are commonly sold in Hawaii (Duke, 1981).

Common beans (*Phaseolus vulgaris*) are native to the tropical areas of Central and South America. They include black, black turtle soup, cranberry, French, great northern, kidney, navy, pink, pinto, and white beans, which are widely grown in many areas around the world. White beans are commonly used to prepare many types of baked beans. Pinto beans are used in many Mexican recipes (Akroyd and Doughty, 1982, Duke, 1981). Data were combined for several types of kidney beans to produce an overall figure for kidney beans.

The broadbean (*Vicia faba*) has been cultivated in the Mediterranean region and the Near East since ancient times. It was the only bean known to Europeans until the common bean (*P. vulgaris*) was introduced from the New World. There are two major subspecies of broadbeans. Var. major, which has large flat seeds, is usually consumed by humans. Var. equina, which has small, globular seeds and commonly called field bean or horse bean, is used for feeding livestock. Broadbeans are used in many dishes in the Mediterranean region, such as falafel (Akroyd and Doughty, 1982).

Carob flour or powder (*Ceratonia siliqua*), also called St. John's bread, may be used in some foods as a chocolate replacement. The seeds are ground to extract a gum, known as locust bean gum, which is used in many food and industrial products. The pods are ground to produce carob flour. Vegetable oil or other fats are frequently added to the raw carob flour to make confectionary coatings or candy bars. The carob tree is native to the eastern Mediterranean region and has been introduced to California and other areas (Akroyd and Doughty, 1982, Duke, 1981).

Chickpeas (*Cicer arietinum*) or garbanzo beans are one of the most commonly consumed legumes in India and in the Middle East (Akroyd and Doughty, 1982). In the United States, canned or cooked chickpeas are a common item at many salad bars. In the Middle East chickpeas are used in many dishes such as hummus and falafel. These items have become more popular in the United States.

Cowpeas (*Vigna unguiculata*), or black-eyed peas, are cultivated in the southern United States and in many tropical areas. There are three major subspecies: *Vigna unguiculata unguiculata* is the common cowpea or black-eyed pea; *Vigna unguiculata cylindrica*, or catjang, is used whole or split but is more frequently used as forage; *Vigna unguiculata sesquipedalis*, or yardlong bean, has pods that may grow to 36 inches in length and is commonly used in Asian cooking as a vegetable. The mature seeds are also used (Akroyd and Doughty, 1982).

Hyacinth beans (*Dolichos purpurens*), also known as lablab, are native to Asia and have been cultivated in India for centuries. The mature seeds are eaten as a dahl.

Lentils (*Lens culinaris*) originated in the Mediterranean area. The seeds are usually boiled and served in soups and stews (Akroyd and Doughty, 1982).

Lima beans (*Phaseolus lunatus*) originated in tropical regions of the Americas and are now grown in tropical and subtropical areas around the world. Baby lima beans grow in most areas of the United States (Duke, 1981). There are two major subgroupings of lima beans: the small or baby type and the large lima beans.

Lupins (*Lupinus* spp.) are found in the Americas and in the Mediterranean region. There are four major species. White or Egyptian lupins (*Lupinus albus*) are common in the Mediterranean region and were cultivated by the Romans. Seeds are treated by soaking, then boiling, and sometimes additional soaking. Sweet strains with less alkaloids have been developed.

Blue lupin (*Lupinus angustifolius*) originated in northern Europe and is grown primarily for animal feed. Yellow lupin (*Lupinus luteus*) is native to southern Europe and the Mediterranean. Low-alkaloid varieties have been developed. Tarwi or pearl lupin (*Lupinus mutabilis*) has been grown in South America for centuries. Special preparation methods are required to remove the alkaloids. Low-alkaloid types are being developed (Akroyd and Doughty, 1982, Duke, 1981). Because of limited data, nutrient values for all four subspecies have been combined in the tables.

Mothbeans (*Vigna aconitifolia*) are native to India and are eaten whole or as a dhal. The seeds are also used as a source of flour (Duke, 1981).

Mung beans (*Vigna radiata*), also called green gram in India, are native to tropical areas of Asia and are widely grown there. Recently, mung beans have been introduced to the United States. In China and the United States mung beans are commonly grown for sprouting and are consumed as a vegetable. The mature seeds can be boiled and eaten. They can also be ground into a flour for use in bakery products and fried snack foods (Akroyd and Doughty, 1982). Mung beans are also made into a noodle-like product called long rice. A similar product made from mung bean flour is cellophane noodles.

Mungo beans (*Vigna mungo*), sometimes called black gram, originated in India and are also grown in the West Indies (Vaughan and Geisler, 1997). Mungo beans are eaten either whole or as a dhal. They also can be boiled or roasted and ground into flour for use in cakes and breads.

Peas (*Pisum sativum*), or field peas, originated in southwest Asia and are now grown in temperate areas around the world (Akroyd and Doughty, 1982). They were once named as different species-—garden peas and field peas—but are now classified

together. Field peas are hardier, have smaller seeds, and are usually grown for the mature seeds.

Peanuts (*Arachis hypogaea*), native to Latin America, are now grown in tropic, subtropic and warm-temperate areas of the world. In the United States over 60 percent of the peanuts are processed into peanut butter, about 20 percent are roasted, and about 19 percent are used in confections (USDA-ERS, 2014). In other countries, peanuts are produced primarily for their oil and the remaining peanut cake is used for livestock feed. The three main types of peanuts are Virginia, Spanish, and Valencia. Virginia peanuts have large seeds and usually contain two seeds per pod. Spanish peanuts have small seeds and their pods also contain two seeds. Valencia peanuts also have small seeds and the pods contain two to five seeds (Brouk, 1975). Nutrient data on the different cultivars of peanuts were combined to generate overall values for peanuts: Virginia (including runner), 90.6 percent; Spanish type, 8.5 percent; and Valencia type, 0.9 percent. By federal regulation (21 CFR 164.150), peanut butter must contain at least 90 percent peanuts, and not more than 10 percent seasonings (including sugar, salt, and oil), and stabilizing ingredients.

Pigeon peas (*Cajanus cajan*), or red gram, were probably native to Africa, spreading in prehistoric times to Asia (Vaughan and Geisler, 1997). In India, pigeon peas are usually consumed as a dahl.

Soybeans (*Glycine max*) are among the most important sources of protein and oil known to man. Indigenous to eastern Asia, where they have been used in myriad ways for centuries, soybeans are now cultivated in eastern and southeastern Asia as well as in the Americas, predominately in the United States and Brazil (Akroyd and Doughty, 1982, Duke, 1981, Vaughan and Geisler, 1997). A number of fermented soybean products are known in east and southeastern Asian countries, and in recent years these have attracted a following in the United States.

Shoyu (Japanese soy sauce) is made from equal parts soybeans and cracked, roasted wheat, plus salt and water. The mixture is inoculated with *Aspergillus soyae* mold and fermented from 6 months to as long as 5 years. Tamari is a different product made with little or no wheat. In the United States a non-fermented, synthetic product known as soy sauce is prepared from hydrolyzed soy protein, caramel coloring, corn syrup, salt, and water (Shurtleff and Aoyagi, 1979a) rather than using the traditional fermentation method. Soy sauces are commonly used as condiments in east and southeastern Asian style cooking. It is also used in western cuisines and prepared foods.

Miso, or soy paste, is made from soybeans, a grain (either rice or barley), salt, and water. The mold *Aspergillus oryzae* is introduced for fermentation (Shurtleff and Aoyagi, 1976). Many different types of miso are marketed and rarely are identified in the scientific literature. Data for a number of market samples have been combined in the database, which explains the somewhat large variation in some nutrient values.

Natto is made from whole, cooked soybeans, which are inoculated with the bacterium *Bacillus subtiis*. Natto is often served over rice or noodles as a main dish or used in soups and salads (Shurtleff and Aoyagi, 1979a).

Tempeh, from Indonesia, is made from cooked soybeans bound together with the mycellia of the mold *Rhizopus mycellius*. The product is made into cakes or patties and often sliced and fried (Shurtleff and Aoyagi, 1979b).

Tofu, another soy product, is prepared by precipitating the protein of soy milk with any of several coagulants. Tofu is prepared by soaking the whole soybeans overnight and later grinding them with water before draining. The resulting soy milk is pressed from the cooked, ground soybeans, leaving a white or yellowish pulp consisting of the insoluble parts of the soybean. This pulp is known as okara, and can be used in many recipes (Shurtleff and Aoyagi, 1979a). Any of several coagulants is then added to precipitate the protein and form the curds. Nigari, the traditional coagulant used in Japan, contains primarily magnesium chloride. Calcium chloride, calcium sulfate, seawater, lemon juice and vinegar can also be used. As expected, the composition of the coagulant affects the calcium and magnesium content of the finished product. Excess liquid is pressed from the curd, which in turn affects the firmness of the tofu (Shurtleff and Aoyagi, 1979a). Tofu is available in a number of "firmness" types, i.e. soft, silken, medium, firm, extra firm, and others reflecting the amount of water pressed from the curd. The amount of water pressed from the tofu, reflected in the firmness term used, will also have concomitant effect on the nutrient content—firm tofu with less water will have a higher nutrient content than soft types with more water. However, there is no standard for these terms, and one company's tofu using a particular term, may be more similar to another company's product using a different term.

Soymilk is a beverage produced commercially from soybeans. In the United States, soy milk may be used by individuals who choose not to consume animal products, are allergic to cow's milk, or who are lactose intolerant. Some infant formulas are based on soy milk. Soy milk can be processed in many of the same ways as cow's milk and can be substituted for it in many recipes.

In the United States and in other countries, soybeans are utilized as a source of oil, and the resulting defatted meal was formerly used for animal feed. In recent years, however, the defatted soy meal has been used in the preparation of many soy-based products. Soy flour and soy grits can also be prepared from the defatted meal. Soy flour is used in many foods as is or may be extruded into various soy-based products. Soy protein concentrates are processed to remove most of the non-protein compounds, primarily soluble sugars, from the defatted soy flour by wet extraction. Concentrates are often extruded in the preparation of many products.

Soy protein isolates have had nearly all the non-protein constituents removed. The soy extract can be either spray-dried or extruded into an acid medium to form fibers resembling meat, which are marketed as textured vegetable protein. Soy protein

isolates are also used as an ingredient in a number of food products, both as a protein extender and for their functional properties.

Modern processing methods have been used experimentally on a number of other legumes, but none have reached large—scale commercial production or have gained the commercial acceptance of soy products.

Winged beans (*Psophocarpus tetragonolobus*) are native to southeast Asia and have been introduced to tropical areas of the United States, such as Hawaii, Puerto Rico, and southern Florida. The pods, leaves, stems, and tubers of this plant are all edible and are included in Food Group 11, Vegetable and Vegetable Products. Only data on the mature seeds, however, are reported here. The mature seeds can be steamed, boiled, roasted, fermented, or processed into milk or into products such as tofu or tempeh (BOSTID, 1981).

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Nut and Seed Products (Food Group 12)

Introduction

There are currently 133 food items in the Nut and Seed Products food group within the USDA National Nutrient Database for Standard Reference (SR). The sources of nutrient data for these items released in SR include the scientific literature, analytical studies, and food industry. In 1999 the International Tree Nut Council (INC) collaborated with the Nutrient Data Laboratory (NDL) to sample and analyze almonds, hazelnuts, macadamias, pecans, pistachios, and English walnuts. Since 2002, additional data were obtained via NDL's National Food and Nutrient Analysis Program (NFNAP) (p. 52) for those nuts as well as almond butter, Brazil nuts, cashews, pine nuts, shredded coconut, and mixed nuts; and flaxseed, pumpkin, sesame and sunflower seeds.

The Almond Board of California provided data on many varieties of almonds commonly grown in California. The Western Pistachio Association (now called American Pistachio Growers) provided data on both raw and dry roasted pistachio nuts. These industry data were then aggregated with the INC and NFNAP data. The remaining nut and seed nutrient data were derived primarily from the scientific literature.

Lightly salted mixed nuts (both with and without peanuts), lightly salted almonds, smoke-flavored almonds and glazed walnuts were added to SR due to their high sales volume. The data were derived from food labels and the food industry.

Apparent nutritional differences in estimates for different forms of nuts and seeds are not necessarily due to the effects of processing or preparation methods. Different forms of nuts and seeds (e.g., raw, oil roasted and dry roasted) usually were not of a common sample origin. Data were obtained from many sources and may represent different growing years, growing areas, cultivars, processing techniques, lengths and conditions of storage, laboratories, and possibly different methods of analysis. The above factors, together with natural variability, may lead to difference in nutrient content not related to the processing or preparation methods. The USDA ARS Germplasm Resources Information Network (GRIN) database (USDA, 2012) was used as the basic reference for scientific names and preferred common names.

Nuts

Several tree nuts are grown in the United States and are commercially important in the food supply. In fact, the United States produces over one-tenth of the world's tree nuts (USDA, 2012). Most coconuts consumed in the United States are imported, but in some tropical areas, coconuts are readily available from the coconut palm tree. Other nuts must be imported, such as Brazilnuts, cashew nuts, European chestnuts, ginkgo nuts, and pine nuts. Detailed information about tree nut imports and exports can be found through the USDA's Economic Research Service at www.ers.usda.gov. Relatively small amounts of some types of nuts are gathered by the consumer, either from the woodlands or from trees used to landscape property. Nuts in this category are

acorns, beechnuts, butternuts, Chinese and Japanese chestnuts, and hickorynuts. Black walnuts are gathered by families across 16 states and bought by nut companies to be shelled and packaged for sale to consumers (Hammons, 2007).

Nearly all nuts must be dried or cured prior to being consumed. Drying nuts to a low moisture content—either by sun drying or by mechanical drying—prevents deterioration of the nut and protects its quality during storage (California Walnut Board, 2011). Although coconuts can be eaten raw, directly from the tree, harvested green coconuts are partially dried or seasoned in the field (Grimwood, 1975). According to USDA's Economic Research Service (2010), the per capita consumption of tree nuts has increased from 2-1/4 pounds in the 1980's and 1990's to 3-1/2 pounds as of 2009.

Almonds (*Prunus dulcis*) make up over 1/3 of the per capita consumption of tree nuts in the US (USDA, 2010). About 80% of the world's supply and approximately 100% of the domestic supply are grown in the Central Valley of California. The market forms available include inshell almonds; shelled almonds in many unblanched and blanched forms (whole, sliced, slivered, chopped, and ground); almond paste made from ground unblanched or blanched almonds blended with sugar; almond butter made from ground dry roasted almonds blended with salt and a stabilizer; almond meal; and almond powder or flour (Almond Board of California, 2010).

Brazilnuts (*Bertholletia excelsa*) come from large trees that grow in the tropical jungles of the Amazon Basin. They are produced mainly in Bolivia, Brazil, and Peru. Both in-shell and shelled Brazilnuts are marketed (INC, 2008). These nuts are known for their very high selenium content, which is highly variable, depending on the geographic location where the nuts are found (Chang, 1995).

Cashew nuts (*Anacardium occidentale*), which are native to Brazil, are cultivated in many tropical countries, especially India, Vietnam, Mozambique and Brazil (INC, 2008). Before the cashew nuts are eaten, the corrosive liquid between the shells must be removed by some form of heat treatment (Woodroof, 1979), generally roasting. Raw cashews have been heat-treated to safely remove the kernel from the shell, but have not been further roasted.

Most **coconuts** (*Cocos nucifera*) eaten in the United States are consumed as dried (desiccated) coconut, a form of coconut meat that has been shredded, disintegrated, and then thoroughly dried in hot air driers (Grimwood, 1975). Unsweetened and sweetened coconut comes in many forms, called cuts. The two types of coconut cuts most often found in retail markets are flaked and shredded desiccated sweetened coconut (General Foods, 1982). Another type of desiccated coconut is toasted coconut which may be either unsweetened or sweetened (Ruehrmund, 1974).

Hazelnut and filbert are names used interchangeably for species of the genus *Corylus* (Hazelnut Marketing Board, 2014; Woodroof, 1979). Hazelnuts are grown commercially in Oregon and Washington, but filberts are also imported from Turkey, Italy, France, and Spain to meet the demand for this nut (Woodroof, 1979; INC, 2008). These nuts are

marketed in-shell and shelled, roasted or salted, and used for the preparation of several food products such as candy and ice cream (INC, 2008).

Macadamia nuts (*Macadamia integrifolia, M. tetraphylla*) are native to Australia. The *M. tetraphylla* variety has a rough shell which is not as good for roasting. The largest producers of macadamia nuts are Hawaii, Australia, South Africa, and Guatemala (INC, 2008). Dry roasted, salted macadamia nuts are readily available throughout the United States.

Botanically, **peanuts** and soybeans are legumes, not tree nuts. Thus, they are found in the Legume and Legume Products Food Group 16.

Pecans (*Carya illinoinensis*) are native to temperate North America, originating in central and eastern areas. The leading producers of pecans are Georgia and Texas, but they are also grown in several other states including Arizona, the Carolinas, Florida, and New Mexico, as well as Mexico. Over 80% of pecans sold have been shelled (NPSA, 2014).

One **pine nut** species, pinyon (*Pinus edulis*), is an important source of food and revenue for Native Americans in the Southwest. Very little recent information on the nutrient content of pinyons is available, except for the unpublished data of Lanner (1975) and Weber (1983). Most pine nuts (*Pinus* spp*.)* are imported from Italy, Spain, China, Portugal, and Turkey (INC, 2008). Pine nuts are marketed in shelled form and are generally used in the confectionery industry (INC, 2008) and as an ingredient in recipes.

Pistachio nuts (*Pistacia vera*) are cultivated in the United States, Iran, Turkey, Greece, Syria, and Italy. California is the major producer of pistachios in the US, with Arizona and New Mexico as additional sources. Pistachios are marketed primarily roasted and salted in their shell, but are also available unsalted and shelled (INC, 2008). Natural ivory-shelled and red-dyed pistachio nuts are available, but the percentage of dyed nuts is currently very small (American Pistachio Growers, 2011).

English walnuts (*Juglans regia*), which are often just called “walnuts,” originated in Persia (now known as Iran). Thus, they were first called Persian walnuts (Woodroof, 1979). After these walnuts were introduced to England and then brought to America they were called English walnuts (Brouk, 1975; Woodroof, 1979). Today, the Central Valley of California is the center of commercial production in the United States: 78% of the world’s supply and nearly all of the US production (California Walnut Board, 2011).

Black walnuts (*Juglans nigra*), are native to North America (Brouk, 1975). These walnuts, which are very hard to crack, are harvested wild from woodlands and from cultivated trees (Brouk, 1975, Woodroof, 1979) in the Midwest and East-Central part of the United States (Hammons, 2007).

Less Common Nuts

Acorns (*Quercus* spp.) are eaten raw, dried, or roasted in many parts of the world. American pioneers and native Americans ground acorns into meal to make bread or to thicken soups (Millikan, 1979). Most acorns contain potentially toxic tannins which must be leached out of the acorns before they are eaten. The literature contains very little recent information on the nutritive value of acorns. Weber, however, has made unpublished data available on the nutrient content of dried acorn kernels and full-fat acorn flour both of which are used by the White Mountain Apache Indians (Weber, 1983). Also see NDB No. 35182 for acorn stew which is an Apache dish.

Although **beechnut** trees (*Fagus spp*.) are found in many wooded areas, very few produce beechnuts that have a sweet flavor (Millikan, 1979). Beechnuts from these trees are difficult to gather for food because of their small size and poor nutmeat development.

Butternuts are another species of *Juglans* (*Juglans cinerea*). The trees are native to the Eastern United States and adjacent areas of Canada (USDA NRCS, 2011). The number of butternut trees in North America has decreased dramatically due to a canker fungal disease and other factors. The tree is considered an endangered species in Canada (Ministry of Natural Resources, 2009) and a species of special concern in all United States National Forests (Woeste and Pijut, 2009). Butternuts are used in baked products and candies due to their oily texture and nice flavor (Woeste and Pijut, 2009).

Almost all of the trees of the American **chestnut** (*Castanea dentata*) have been destroyed by fungus blight. Today, Chinese chestnut (*Castanea mollissima*) trees, which are blight resistant, are sold in place of the American chestnut for yard and orchard culture (Jaynes, 1979). Some Japanese chestnuts (*Castanea crenata*) are imported from Japan and some are grown in the United States, although these chestnuts are not as well adapted to the North American climate as the Chinese chestnuts (Jaynes, 1979). European or Italian chestnuts (*Castanea sativa*) are available in markets around the holiday season and are also sold roasted on street corners of some cities.

Dried **ginkgo nuts** (*Ginkgo biloba*) resemble almonds but are whiter, fuller, and rounder (Hedrick, 1972). Canned ginkgo nuts imported from Japan are readily available in Asian markets in the United States.

Hickorynuts, which are native to the woodlands of the United States, belong to the *Carya* species (Woodroof, 1979). Shagbark hickorynuts (*Carya ovata*) are moderate in size and thin shelled, while shellbark hickorynuts (*Carya laciniosa*) are larger nuts with a thick shell (Woodroof, 1979).

Pilinuts (*Canarium ovatum*) are imported from the Philippines. In the United States, markets featuring Philippine foods stock candied pilinuts.

Seeds

Seeds are grown primarily for their edible oils, because they have a very high fat content. Some seeds are eaten with very little home or commercial processing. Like nuts, some of the seeds are commercially important and can be easily purchased in retail or wholesale markets. Other seeds are available only to those having access to the growing plants or trees.

Both **pumpkin and squash seeds** (*Cucurbita* spp.) are consumed in the United States. Dried pumpkin and squash seeds and roasted pumpkin seeds are available in retail markets. Whole squash seeds are eaten roasted and salted by the Navajo Indians (Weber, 1983).

Safflower seed (*Carthamus tinctorius*) is grown in the United States – primarily California – as well as in Mexico, India, and the Middle East (US ITC, 2003). Although there has been some interest in using safflower seed meal and flour, safflower is cultivated primarily for oil in the seeds.

During the Civil War, **cottonseed** (*Gossypium* spp.) was parched and ground as a coffee substitute in the South (Hedrick, 1972). Today, glandless cottonseed products such as roasted kernels, flour, and meal are used as ingredients in a variety of products (Simmons, 1980) such as candy and baked products.

Sesame seed (*Sesamum indicum*) is native to East Africa and is grown in China, India, Ethiopia, Sudan, Nicaragua, Mexico, Guatemala, and the United States (Brouk, 1975). A paste form of sesame butter is made from the whole seed, while tahini, another type of sesame butter, is made from the kernel.

In the summer, **watermelon seeds** (*Citrullus lanatus*) are readily available from raw watermelons, but are probably seldom eaten from this source. Dried watermelon seeds, imported from Thailand and Taiwan, can be found in Asian markets in the United States.

Breadfruit trees (*Artocarpus altilis*) are found throughout the Tropics. Although most breadfruit trees bear fruit that is seedless, some cultivars contain seeds. In the seeded cultivars, the fruit pulp is almost nonexistent and the breadfruit seeds take up almost all the space inside the fruit (Brouk, 1975). Breadfruit seeds are boiled, roasted, or fried as a snack. They can also be ground into flour or used as nuts in baked products (FAO, 1989, South Pacific Commission, 1983).

In the American Tropics and Mexico, the **breadnut tree** (*Brosimum alicastrum*) produces yellow fruit with single seeds, also called ramóns (Peters and Pardo-Tejeda, 1982). The seeds are eaten raw or boiled and can be toasted and ground into a meal to make flatbread or a coffee-type beverage (Rocas, 2003).

One of the species of **Sisymbrium** (*Sisymbrium* spp.) is also known as tumble mustard. Native Americans of the Navajo nation use these dry ground seeds, which they call "k'ostse," as an ingredient of cornbread (Weber, 1983). Small-seeded plants that differ botanically from cereals, but that are cultivated like cereals in fields and ground into flour to make bread and similar products, are called pseudo-cereals (Brouk, 1975).

One of these pseudo-cereals is **chia seed** (*Salvia hispanica*) which is native to Mexico (Brouk, 1975).

The sacred **lotus** (*Nelumbo* spp*.)* is an aquatic plant found in China and India (Brouk, 1975). In the United States, Asian markets stock the dried, whole lotus seed which is imported from China. Traditionally, the seeds are roasted, candied, cooked in soup, and made into a paste for sauces and moon cakes (Dharmananda, 2002).

Cultivars of the confectionery type of **sunflower seeds** (*Helianthus annuus*) are generally black with white stripes and are larger than oilseed type cultivars (Adams, 1982). Whole sunflower seeds, sunflower kernels, and sunflower butter are sold.

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Pork Products (Food Group 10)

Introduction

Nutrient and food composition data for pork products are presented in the USDA National Nutrient Database for Standard Reference (SR). The data in SR represent the amount of each constituent in 100 grams of edible portion. The edible portion of pork may be represented as "separable lean and fat" or as "separable lean only". In each case, bone and connective tissue are removed from the cut and reported as refuse. In the case of "separable lean and fat", it is assumed that all fat present is consumed. For items described as "separable lean only", all external trim fat as well as trimmable seam fat are removed from the cut, and included in the reported refuse. Weights are determined for the whole retail cut as purchased, and for each component (e.g., refuse, separable lean, etc). The external trim fat and the seam fat are combined for analyses, weighed, and reported as separable fat. Nutrient analyses are conducted on the separable lean and the separable fat. The nutrient values for separable lean and separable fat are combined and weighted for their respective contributions to the whole retail cut; the resulting food items are reported as "separable lean and fat". For cooked pork cuts, the cuts are cooked with the separable fat intact. Nutrient data for separable fat, separable lean only, and separable lean and fat of cooked cuts are analyzed or calculated as described above.

The analytical nutrient data includes the mean nutrient value, the standard error given to three decimal places, and the number of observations on which the values are based. For many food items, mean values are given without an accompanying standard error and number of samples. These values are either calculated by pooling data or by weighting means, by applying cooking yields or nutrient retention factors to derive values for some cooked foods, or by imputation from a different, closely related food. For raw pork items and unheated cured items, nutrient values were calculated based on known content of the nutrient in the lipid (fatty acids), total solids (cholesterol), moisture-free, fat-free solids (minerals), or protein (water-soluble vitamins) fractions.

Nutrients

Nutrient information for SR can be found under "File Content" in the documentation. However, some nutrient information specific to pork products are included here. Nutrient values are obtained for moisture, protein, ash, and total fat. The values for protein are calculated from the content of total nitrogen (N) in the food using the conversion factor recommended by Jones (1941). The specific factor for protein applied to pork items is 6.25. The carbohydrate content of uncured products (except for some organ meats) consisting entirely of pork is negligible, and the carbohydrate content is thus assigned a zero value. The sum of the percentages of water, protein, total lipid, and ash do not necessarily equal 100 percent for those foods showing zero carbohydrate because the amounts of each of these constituents were determined independently.

Food energy is expressed in terms of both kilocalories and kilojoules and represents the physiological energy value remaining after losses in digestion and metabolism have been deducted. (One kilocalorie equals 4.184 kilojoules). A broader discussion on energy and calorie factors used in SR can be found under "Food Description" file in the documentation.

The specific calorie factors used for calculating energy values in pork products are:

	Kcal/g
Protein	4.27
Fat	9.02
Carbohydrate	3.87

The carbohydrate factor of 3.87 is used for estimating energy values for some organ meats and some cured products. The factors are based on the Atwater system for determining energy values. Details of the derivation of these factors are outlined in Agriculture Handbook No. 74 (1973). Because the level of carbohydrate in separable lean and separable fat is insignificant, no carbohydrate factor is needed for these products.

Description of Projects

A series of projects have been conducted to update the pork cuts in the USDA National Nutrient Database for Standard Reference (SR). The studies documented in these notes on pork represent only data collected since 2005. These projects are described in detail below:

Natural Fresh Pork Cuts

Nutrient composition data for fresh pork products in the SR had not been updated since 1991. Since that time, changes in animal husbandry practices and industry procedures led to the availability of leaner cuts. In order to provide up-to-date nutrient information on fresh pork products in SR, the NDL, in collaboration with scientists at the University of Wisconsin and the National Pork Board, conducted a study to determine the nutrient composition of nine (9) fresh pork cuts. This study was funded in part by the National Pork Board. The cuts chosen for evaluation were bone-in shoulder blade steak, boneless tenderloin roast, boneless top loin chop, boneless top loin roast, bone-in sirloin roast, bone-in center loin chop, bone-in center rib chop, bone-in country-style ribs, and bone-in spare ribs. Data from this project were disseminated in a separate report on the NDL web site titled "The Revised USDA Nutrient Data for Fresh Pork" in 2006 and were later incorporated in SR20 (2007). New data obtained to update existing data for pork top loin chops, raw and cooked (broiled), are disseminated in SR 27(2014).

Sampling: Nine fresh pork cuts were pre-ordered and purchased from 12 retail outlets using the nationwide sampling plan developed for NFNAP (Perry *et al*., 2003) and

shipped frozen to the University of Wisconsin for trimming and preparation. Products from each location were assigned randomly to either raw or cooked preparation. For roasts and spare ribs, each roast or rack of ribs was randomly assigned to either raw or cooked preparation.

Preparation - Cooking procedures:

Broiling (Center Loin Chops, Center Rib Chops, Top Loin Chops). Chops were grilled on a pre-heated George Foreman™ Indoor/Outdoor Electric Barbeque Grill for 10 minutes, setting "4". External fat thickness and chop thickness were measured prior to cooking; weights of raw cuts were obtained. Two (2) thermocouples were placed into one (1) or two (2) chops, as needed. Chops were turned over when the internal temperature reached 100°-105°F (38°-41°C). Chops were removed from the grill to attain a final internal temperature of 160°F/71°C (chops were taken off the grill at approximately 155°F/68°C internal temperature). Chops were cooled on a wire rack for 5 minutes and the highest internal temperature attained during the standing period was recorded. After standing for 5 minutes, chops were re-weighed.

Roasting (Top Loin, Tenderloin, and Sirloin Roasts). Oven was pre-heated to 325°F/163°C (425°F/218°C for tenderloin roast). Top loin, tenderloin, and sirloin roasts were weighed raw, and placed on a rack in a pan for cooking. Top loin roasts (boneless) were roasted as "single" loin roasts (one loin muscle only). If the purchased product was "double top loin roast (boneless)", i.e. two single top loin roasts backed and tied together, the strings were removed, and each half of the double top loin roast was processed as a single top loin roast. Roasts were cooked uncovered. An oven-durable meat thermometer was placed into the geometric center of the roast. Roasts were removed when they achieved an internal temperature of ~150°F/65°C; the target final internal temperature was approximately 160°F/71°C. Roasts were allowed to stand 15 minutes; the final internal temperature was determined during this period. The cooked weight of the roast was obtained and the cooking yield calculated.

Roasting (Spareribs). The oven was pre-heated to 325°F/163°C. No external fat measurements were collected, but any gross physical fat (loosely attached) from the raw ribs were removed before cooking. The raw weight of the spareribs was obtained. The number of ribs in the product being cooked was recorded. Spareribs were placed on a rack in a pan, but were not covered during cooking. Ribs were roasted for 1 hour and 45 minutes. Ribs were then removed from the oven; the temperature in the intercostal muscles was immediately taken. Ribs were cooled for 10 minutes, and then re-weighed. When cool enough to process, edible lean was separated from bone/cartilage. Trimmable fat and connective tissue are not an issue in cooked ribs, since it is assumed that, with this product, all soft tissues are consumed.

Braising (Shoulder Blade Steaks and Country-Style Ribs). Oven was pre-heated to 325°F/163°C. The raw blade steaks and/or country-style ribs were weighed. The thickness of the external fat around the outer surface of the cuts was measured. Blade

steaks or country-style ribs were placed on a rack in a roasting pan. Distilled water (100 ml) was added to the roasting pan, which was covered tightly and placed in the center of the oven. Cooking time was determined from initial trials. Initial cooking time estimates were: 45 minutes for blade steaks; 1 hour and 15 minutes for country-style ribs. The internal temperature was determined with an electronic digital thermometer. Steaks and/or ribs were allowed to cool for 5 minutes and then re-weighed and the weight was recorded.

Sample preparation - raw and cooked products:

Measurement of external trim (separable) fat. For all chops, blade steaks, and country-style ribs, external fat at the 1/4", 1/2" and 3/4" points along the external fat surface of the product were measured in millimeters. External fat thickness was measured at each of these points. For top loin and sirloin roasts, fat thickness measurements were taken over the center of the exposed fat at the 1/4", 1/2" and 3/4" points along the length of the roast. External fat measurements were not determined on tenderloin roast or spareribs.

Separation of lean meat, separable fat, connective tissue, and bone. Dissection of pork cuts was performed from the perspective of a "careful consumer", who conscientiously separates these tissues. The most difficult separation is between the trimmable (separable) fat and connective tissue, which lies in the "seams" between muscles. The separation was accomplished by "scraping" the co-mingled tissues with a knife blade, such that the soft fat was separated from the tougher, stringy connective tissue. Separable lean tissue should be relatively free of trimmable fat, while the trimmable fat should be reasonably free of connective tissue.

Separable lean meat, separable fat, and connective tissue were removed from bones as cleanly as possible. Separable fat (i.e., external trim fat and seam fat), bone, and connective tissue were removed from raw and cooked products and weighed to determine the relative amounts of separable fat and separable lean meat. Component weights (i.e., weights of separable lean, separable fat, bone, and connective tissue) were reported in SR; weights of connective tissue and bone were combined and reported as "refuse". For food items listed "lean only", the separable fat associated with that cut is considered "refuse"; for food items listed "lean and fat", the separable fat is considered edible and contributes to the nutrient profile.

Sample composites and nutrient analyses:

Shoulder blade steak, tenderloin roast, and top loin chops. Shoulder blade steak, tenderloin roast, and top loin chops represent different areas of the pig and are most commonly cooked by grilling, roasting, and braising, respectively. For purposes of this study, these were referred to as the primary cuts since complete nutrient profiles were obtained for both the raw and cooked preparations of these cuts. For each cut, the lean tissue cuts purchased from an individual location were combined into individual composites for homogenization and nutrient analysis; for some nutrients (proximates,

minerals, cholesterol, thiamin, niacin, and riboflavin), the number of observations (n) = 12. For pantothenic acid, vitamin B_6, and vitamin B_{12}, samples from the three locations were combined to form regional composites (n = 4). One of these composites was randomly chosen and analyzed for retinol (Vitamin A); n = 1. Separable fat from all cuts were combined to form raw and cooked composites. Complete nutrient profiles were determined for each of these composites (raw and cooked).

Top loin roasts, sirloin roasts, center loin chops, center rib chops, country-style ribs, and spare ribs. Proximate nutrients and minerals were analyzed from individual composites for both the raw and cooked preparations of top loin roasts, sirloin roasts, center loin chops, center rib chops, country-style ribs, and spare ribs. For these cuts, cholesterol, thiamin, niacin, and riboflavin were determined from the regional composites of the cooked samples. For some nutrients, values were imputed using established NDL procedures described above. Nutrient values for pantothenic acid, vitamin B_6, and vitamin B_{12} for these cooked cuts were imputed from the primary cuts prepared (cooked) in the same manner. Nutrient values (cholesterol, thiamin, niacin, and riboflavin, pantothenic acid, vitamin B_6 and vitamin B_{12}) for the raw preparations were imputed from their cooked counterparts. A commercial laboratory, whose analytical procedures were evaluated through the NFNAP process and found to be acceptable, performed tissue homogenization and nutrient analyses.

Enhanced Pork Cuts

Enhanced pork is the process of adding non-meat ingredients to fresh pork to improve the eating quality of the final product where eating quality is defined as the juiciness, tenderness, and flavor of pork (National Pork Board, 1998). As meat producers increasingly raise leaner animals that contain significantly less fat, alternative processes are being developed to replace the flavor loss due to fat reduction and reduce moisture loss resulting from cooking. Enhancing the meat is one such process. Since SR did not provide data for the nutrient content of enhanced meat, a collaborative study was conducted by scientists at USDA, the University of Wisconsin, and the National Pork Board to determine the nutrient profile of the following enhanced products: shoulder blade steak, tenderloin, and top loin chops. This project was funded in part by the National Pork Board. Data for enhanced pork cuts were disseminated in SR20 (2007). New data obtained to update existing data for enhanced pork top loin chops, raw and cooked (broiled) are disseminated in SR 27 (2014).

Sampling. Three fresh, enhanced pork cuts were pre-ordered and purchased from 12 retail outlets using the nationwide sampling plan developed for NFNAP (Perry *et al*., 2003) and shipped frozen to the University of Wisconsin for trimming and preparation.

Preparation and analysis. Preparation, compositing, and nutrient analyses for enhanced versions of the shoulder blade steak, tenderloin, and top loin chops were similar to those described for natural fresh pork cuts (see above).

Pork Value Cuts

USDA, in collaboration with the National Pork Board and University of Wisconsin, conducted a study to determine the nutrient profile of four new pork value cuts. This project was funded in part by the National Pork Board. These cuts were introduced to the retail market in 2008-2009. Pork value cuts are individual muscles chosen from the shoulder and the leg. These cuts were selected for their strong marketability, consistency in flavor and tenderness, availability, and economic feasibility for food chains and consumers. The common names of the four new cuts selected, the scientific name for the muscle, and the part of the carcass from which they originate are as follows:

- Pork Shoulder Breast Boneless (Pectoralis profundi) – shoulder
- Pork Shoulder Petite Tender Boneless (Teres major) - shoulder
- Pork Leg Cap Steak Boneless (Gracilis) – leg
- Pork Leg Sirloin Tip Roast Boneless (Vastus lateralis and Rectus femoris) – knuckle and leg.

The nutrient profiles of these four new cuts were released in SR21 (2008).

Sampling. A total of 14 paired cuts for each pork value cut were obtained from pork production plants in North Carolina and Iowa. At each plant, both shoulder and hams from 7 randomly selected pork carcasses were obtained. Carcasses were of average weight or slightly heavier to ensure an adequate amount of sample. Proper cut identification of each ham and shoulder from each plant was maintained throughout the fabrication process. Each muscle was denuded, trimmed free of all external fat and connective tissue, and frozen prior to shipment to the University of Wisconsin.

Sample Preparation. Among the 7 paired products from each of the two locations, 6 pairs were randomly selected for use in the study. One member of each pair was prepared as raw and the other was cooked either by broiling or braising to a desired internal temperature or time end-point. After a designated cooling period, the cooked product was cubed, hand mixed, and divided into individual carcass samples, and composites of two or three carcasses.

The designated cooking method for each pork value cut were:

- Pectoralis profundi – broiled
- Teres major – broiled
- Gracilis – broiled
- Rectus femoris – braised

Cooking methods, broiling. Cuts were grilled on a pre-heated George Foreman™ Indoor/Outdoor Electric Barbeque Grill for 10 minutes on setting “4”. Raw cuts were weighed prior to cooking. Internal cooking temperatures were determined by insertion of thermocouples. Cuts were turned-over when the internal temperature reached 100°-105°F (71°-41°C). Cuts were removed from the grill to attain a final internal temperature of 160°F/71°C (cuts were taken off the grill at approximately 155°F/68°C internal

temperature). After standing 5 minutes, cuts were re-weighed and the highest internal temperature was attained during the standing period and recorded.

Cooking methods, braising. Oven was pre-heated to 325°F/163°C. Temperature was monitored with an oven thermometer. The cuts were weighed prior to cooking and then placed on a rack in a roasting pan. Distilled water (100 ml) was added to the roasting pan, which was covered tightly and placed in the center of the oven. Cuts were braised until reasonably tender. Cooking time was determined from initial trials. Initial cooking time estimates were: 45 minutes for blade steaks; 1 hour and 15 minutes for country-style ribs. Immediately after removal from the oven, the product was placed on a wire rack. The internal temperature was determined with an electronic digital thermometer. Cuts were allowed to cool for 5 minutes and then weighed.

Sample analyses. Proximate nutrients (moisture, total fat, ash, and protein) and cholesterol were determined on individual muscle samples from the shoulder, leg and knuckle, both raw and cooked. For each cut, three samples were pooled into composites and analyzed for fatty acids. Vitamins and minerals were analyzed on samples from the two-carcass composites. Choline and folate analyses were done on the three-carcass composites, raw and cooked. Amino acids were also analyzed on the three-sample composites - raw samples only.

Cured Hams

A new study on cured ham products was conducted by the NDL in collaboration with the University of Wisconsin to update the nutrient profile of various cured ham products in the SR. The word Ham refers to pork meat from the hind leg of a hog. Ham products were available in bone-in or boneless forms.

Cured hams are classified into four categories (USDA-FSIS, 2007):

- Ham - at least 20.5% protein in the lean area with no water added;
- Ham with Natural Juices (HNJ) - at least 18.5% protein with a small addition of water when cured;
- Ham - Water added (HWA) - at least 17% protein with no more than 10% added solution;
- Ham and Water Product (HWP) - less than 17% protein and contains any amount of water but labeling must indicate percentage of “added ingredients”.

“Added ingredients” may vary for each ham product. These solutions, flavorings or “added ingredients” may include water, sugar, salt, sodium erythrobate, sodium nitrite, potassium, and magnesium leading to flavor enhancement. Binders such as soy or milk proteins may also be added to help hold water in the ham. These additions of water and flavor enhancers in ham affect its taste and texture.

Sampling. The sampling plan used for the study was developed for NFNAP (Pehrsson *et al*., 2000). The country was divided into four regions, with three consolidated

metropolitan statistical areas (CMSA) within each region; two retail stores were selected within each CMSA. Eight different types of ham products were picked up from 12 retail outlets nationwide: 1) ham, bone-in whole; 2) ham, bone-in, shank half; 3) ham with natural juices, bone-in rump; 4) ham with natural juices, bone-in butt half; 5) ham with natural juices, bone-in spiral sliced; 6) ham, water added, bone-in, slice; 7) boneless hams (many shapes and sizes); and 8) ham and water product, boneless slices, any type, and/or glazed with sugar, honey, and other ingredients. The sampling procedure for each category of bone-in hams was to select two half-hams. One of those was a shank-half portion and the other a rump-half portion. It was preferable that the two halves should come from the same manufacturer and from the same category. Pairs of selected, branded, bone-in hams (Maple, Haen, and Brandon) were picked-up for retention studies. All products were vacuum packaged, individually labeled, and sent frozen to University of Wisconsin for further cooking and dissection.

Sample preparation. All hams (bone-in and boneless; heated and unheated) were weighed, measured for thickness, and dissected to separate external fat and seam fat. Bone-in hams were further dissected for removal of bone and connective tissue prior to nutrient analyses. Branded hams or paired bone-in whole hams were cut into shank, butt, and slices. One portion from each pair (rumps and shanks) was analyzed "as purchased" and the other roasted to an internal temperature >160°F (71°C). Slices were weighed and measured for thickness prior to being pan-fried to an internal temperature of 64-82°F (18°-28°C). All other types of bone-in and boneless hams were either roasted in a 325°F (163°C) convection oven or pan-broiled to the internal temperature specified on the label. No fat was added during any cooking preparation.

Sample analyses. Proximate nutrients (moisture, total fat, ash, and protein) cholesterol, vitamins, and minerals were determined on all categories of bone-in and boneless hams, both heated and unheated. Total sugars and fatty acids were analyzed on all bone-in and boneless forms of "Ham", "Ham with natural juices" and "Ham and water product". Two pairs of "Ham" types, heated and unheated, were analyzed for vitamin K, retinol, choline, and amino acids (unheated only).

References for Notes on Foods – Pork Products

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US Department of Agriculture, Food Safety and Inspection Service. Ham glossary – Ham and food safety fact sheet. Version current 2013. Internet: http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/meat-preparation/ham-and-food-safety/ct_index (accessed 30 June 2014).

Poultry Products (Food Group 05)

Introduction

Data for poultry products including chicken, turkey, and other fowl are presented in the USDA National Nutrient Database for Standard Reference (SR). For most listings of fresh chicken or turkey, nutrient values are given either for specific market types such as broiler or fryer chicken, young tom turkey, young hen turkey, or as "all classes" to indicate that the values represent one or more unidentified market types for the species.

The data in SR represent the amount of each constituent in 100 grams of edible portion. Edible portion for poultry may be represented as "meat and skin" or as "meat only". In both cases, bone, cartilage, and separable fat are removed from the meat and reported as refuse. Weights are determined for the whole bird as purchased and as parts (breast, thigh, wing, drumstick, back), skin, and refuse (bone and cartilage). Refuse is reported as percentages in the SR Full Report format.

Nutrient analyses are conducted for meat and for skin in both raw and cooked forms. Nutrient values for meat only and for skin only are weighted proportionally, according to their respective contributions to each intact bird part (as purchased), or part of the whole bird, and then reported as "meat and skin." Cooked poultry has been cooked with the skin intact, unless otherwise indicated.

The analytical nutrient data include the mean nutrient value, the standard error given to three decimal places, and the number of observations on which the values are based. For many food items, mean values are given without an accompanying standard error and number of samples. These values are either calculated by pooling data by or by weighting means, by applying cooking yields and/or nutrient retention factors, or by imputation from a different, closely related food. For poultry, nutrient estimates are based on the nutrient value for lipids (e.g., fatty acids), total solids (e.g., cholesterol), moisture-free, fat-free solids (e.g., minerals), or protein (e.g., water-soluble vitamins) fraction of a similar food.

Nutrients

Nutrient information for SR can be found under "File Content" in the documentation. In addition, nutrient information which is specific to poultry products is provided in this report. Nutrient data are obtained for moisture, protein, ash and total fat. The values for protein are calculated from the content of total nitrogen (N) in the food using the conversion factor recommended by Jones (Jones, 1941). The specific factor for protein applied to poultry items is 6.25. The carbohydrate content of uncured products consisting entirely of poultry (except some organ meats) is negligible. For such foods, the carbohydrate content is assumed to be zero.

For heart, liver, giblets, and cured poultry products (foods which are expected to contain carbohydrate), the carbohydrate value is calculated as the difference between 100 and the sum of the percentages of water, protein, total lipid, and ash. If the total of these constituents for an item is more than 100 due to analytical variation, the carbohydrate content is assigned a zero value.

Food energy is expressed in terms of both kilocalories and kilojoules; one kilocalorie equals 4.184 kilojoules. The data are the physiologic energy values which remain after losses due to digestion and metabolism have been deducted. Further discussions on energy and caloric factors used in SR can be found in the "Food Description File" of the general documentation.

The specific calorie factors used for calculating energy values in poultry products are:

	Kcal/g
Protein	4.27
Fat	9.02
Carbohydrate	3.87

The carbohydrate factor of 3.87 is used for some organ meats and some cured products. Because the level of carbohydrate in poultry meat and skin is insignificant, no carbohydrate factor is needed for most poultry products. The factors are based on the Atwater system for determining energy values. Details of the derivation of these factors are outlined in Agriculture Handbook No. 74 (Merrill, 1973).

Description of Projects

The studies documented in these poultry notes represent data collected since 2008.

Rotisserie chicken

In collaboration with Texas Tech University, the USDA conducted studies to determine the nutrient composition of commercially prepared rotisserie chicken. The studies were conducted because rotisserie chicken has become a popular ready-to-serve poultry item in the retail market. A study was conducted to obtain data for rotisserie chicken original flavor, released in SR21 (2008) and rotisserie BBQ flavor chicken released in SR25 (2012). New data on rotisserie chicken original flavor were obtained to update the existing values and were released in SR27 (2014).

Sampling: Rotisserie chicken samples were procured nationwide from 12 retail locations using the National Food and Nutrient Analysis Program (NFNAP) nationwide sampling plan developed for the USDA (Perry et al, 2003).

Sample preparation: Samples were purchased whole and dissected into separate parts: breast, thigh, wing, drumstick, and back. Each bird was weighed whole. After dissection, parts were weighed separately, with and without skin. Refuse including

drippings, bone, subcutaneous fat, and cartilage was also weighed. Samples were homogenized and composited.

Sample analysis: Samples were chemically analyzed by qualified laboratories for nutrient content for the breast, drumstick, thigh, wing, back, and skin. Since rotisserie chicken as purchased is already cooked, samples were analyzed only as cooked, not raw. To validate all analytical procedures, quality control was monitored by use of duplicate sampling, in-house control materials, and certified reference materials.

The rotisserie chicken purchased at each individual location was used to create individual composites for analyses of proximate nutrients (moisture, total fat, ash, and protein), minerals, niacin, vitamin B6, thiamin, riboflavin, pantothenic acid, vitamin B12, cholesterol, and fatty acids. Composite samples from individual locations were grouped for analyses of selenium, folate, choline, vitamin E, amino acids, carotenoids, retinol, vitamin D, vitamin C, and vitamin K.

Whole turkey

USDA conducted a study in collaboration with Texas Tech University to determine the nutrient composition of raw and roasted whole turkey for inclusion in the USDA National Nutrient Database for Standard Reference (SR). The study was initiated due to changes occurring in the industry. For example, during sampling and market checks done by the Nutrient Data Laboratory, most whole turkeys found in retail outlets were labeled as enhanced with sodium-containing solutions, while non-enhanced whole turkeys were relatively uncommon. Therefore, due to the relatively common and recent availability of enhanced whole turkey, data for this product were needed in SR.

Sampling: Samples of whole enhanced turkeys were procured from 11 retail locations, using the nationwide sampling plan developed for the USDA's National Food and Nutrient Analysis Program (NFNAP). Due to unavailability of non-enhanced turkeys in the NFNAP retail locations, samples of non-enhanced turkeys were obtained through 4 different local retail sources. Two turkeys per location were purchased—one to be dissected and analyzed raw and the other to be dissected and analyzed after roasting. All of the turkeys were shipped to Texas Tech University for processing. Weights of meat, skin, and other components were obtained in order to determine cooking yields. Samples of meat, skin and offal (gizzard, heart, and liver) were homogenized, composited, and chemically analyzed for nutrient content.

Cooking Procedure: Roasting -Thawed turkeys were unwrapped and the weight of the drippings, neck, organ meats, and packaging were measured. Oven was preheated to 325^{o}F/163°C. The turkeys were placed on a wire rack in a shallow roasting pan, with 1/2 cup water added in the bottom of the pan. Turkeys were roasted until they achieved an internal temperature of 165^{o}F/74°C, when they were removed from the oven. After 20 minutes at room temperature, the cooked weight of each whole turkey was obtained.

Sample preparation: Separation of meat, skin, separable fat, cartilage, and bone- Each turkey was cut into parts: breast, wings, drumsticks, thighs, and back including the tail. Each part was weighed and refrigerated for up to 24 hours. Dissection of each turkey part was performed by carefully "scraping" the co-mingled parts with a knife blade, so that the separable fat, bone, and cartilage were separated from the meat as closely as possible, and then weighed, to measure the amount of each component.

Component weights (i.e., weights of meat, skin, separable fat, bone, and cartilage) were reported in SR. Weights of bone and cartilage were combined and reported as "refuse". For food items listed as "meat only", the skin and separable fat associated with those cuts is included in the "refuse". For food items listed "meat and skin", the skin and separable fat are considered edible and thus contribute to the nutrient profile so are not included in the refuse.

Sample composites and nutrient analyses: For each analytical sample, the turkeys purchased at each individual location were used to create an individual composite. For the enhanced turkey data, a composite of light meat and a composite of dark meat from each location were paired (n=6), then homogenized and analyzed in both raw and cooked forms. For the non-enhanced turkey data, each location was analyzed separately (n=4) for both the raw and cooked forms. Skin samples from the entire bird were pooled and analyzed both in raw and cooked forms. At this level, these nutrients were analyzed: proximate nutrients (moisture, total fat, ash, and protein), minerals, cholesterol, fatty acids, thiamin, niacin, riboflavin, vitamin B6, and vitamin B12.

Samples from two or more locations were combined to form regional or national composites for enhanced and non-enhanced turkey for these nutrients: amino acids, choline, vitamin K, folate, and retinol. Values for vitamin D, including 25-hydroxy vitamin D, were also obtained from regional composites. Nutrient analyses were performed by TTU and a commercial laboratory, whose analytical procedures were evaluated and validated through the NFNAP process. Regional composites of enhanced turkey were also analyzed for sugar and starch.

In SR, turkey listings are described as light meat, dark meat, or by specific parts. Listings in previous versions of SR also included turkey classes such as fryer, hen, or tom in some of the descriptions. However, terms used to identify specific turkey classes are no longer included in SR, since turkeys sold in the current market are not consistently identified with this information.

As a result of this study, data have been generated to create new SR items for these enhanced whole turkey items: light meat, raw and cooked (with and without skin), dark meat, raw and cooked (with and without skin), gizzard, heart, liver, neck, back, breast, wings, drumstick and thigh. Data have also been generated to update these non-enhanced whole turkey items: light meat, raw and cooked (with and without skin), dark meat, raw and cooked (with and without skin), gizzard, heart, liver, neck, breast, wings, drumstick and thigh.

Retail turkey parts

USDA conducted a study in collaboration with Texas Tech University to determine the nutrient composition of raw and roasted retail turkey parts for inclusion in the USDA National Nutrient Database for Standard Reference. The study was initiated to obtain data for these items available to consumers as an alternative to purchasing whole turkey.

Sampling: Samples of turkey drumsticks, thighs, breast, and wings were procured from 12 retail locations, using the nationwide sampling plan developed for the USDA's National Food and Nutrient Analysis Program (NFNAP). The parts in this study were not labeled as having been enhanced with sodium-containing solutions except for the breast, for which both enhanced and non-enhanced samples were procured. The parts were shipped to Texas Tech University for processing. Weights of meat, skin, and other components were obtained in order to determine cooking yields. Samples of meat and skin, both raw and cooked, were homogenized, composited, and chemically analyzed for nutrient content.

Cooking Procedure: Roasting - Thawed turkey parts were unwrapped and weighed. The oven was preheated to 350°F/176°C. The turkey parts were placed on a wire rack in a shallow roasting pan, with no water added to the pan. Thermocouples were placed in the thickest portions of the pieces. The parts were roasted, uncovered, to an internal temperature of 165°F/74°C, when they were removed from the oven. After 30 minutes at room temperature, the cooked weights were obtained.

Sample preparation: Separation of meat, skin, separable fat, cartilage, and bone- After weighing, the parts were refrigerated for up to 24 hours. Dissection of each turkey part was performed by carefully scraping the co-mingled parts with a knife blade, so that the separable fat, bone, and cartilage were separated from the meat as closely as possible then weighed, to measure the amount of each component.

Component weights (i.e., weights of meat, skin, separable fat, bone, and cartilage) are reported in SR. Weights of bone and cartilage have been combined and reported as "refuse". For items listed as "meat only", the skin and separable fat associated with those cuts is included in the "refuse". For items listed as "meat and skin", the skin and separable fat are considered edible and thus contribute to the nutrient profile so are not included in the refuse.

Sample composites and nutrient analyses: For each analytical sample, the turkey part purchased at each individual location was used to create an individual composite. For the drumsticks and wings, composites from each location were paired (n=4 or 6) then homogenized and analyzed in both raw and cooked forms. For the thighs and breast, each composite location (n=3 or 5) was homogenized and analyzed separately in both raw and cooked forms. Skin samples from the thigh and drumsticks were pooled and analyzed both in raw and cooked forms for the 'skin from dark meat' item.

At this individual composite level, proximate nutrients (moisture, total fat, ash, and protein) and minerals were analyzed.

Samples from two or more locations were combined to form regional or national composites for these nutrients: cholesterol, fatty acids, thiamin, niacin, riboflavin, vitamin B6, vitamin B12, carotenoids, and retinol. Values for amino acids and choline were also obtained from regional composites. Nutrient analyses were performed by TTU and a commercial laboratory, whose analytical procedures were evaluated and validated through the NFNAP process.

As a result of this study, data have been generated to create new SR items for enhanced turkey breast, non-enhanced turkey drumsticks, thighs, breast, and wings (with and without skin), and skin from dark meat.

Whole turkey parts study

USDA conducted a study in collaboration with Texas Tech University to determine the nutrient composition of raw and roasted whole turkey parts enhanced and non-enhanced from whole turkeys for inclusion in the USDA National Nutrient Database for Standard Reference (SR). Samples of whole enhanced turkeys and 4 non-enhanced turkeys were procured from 11 retail locations, using the nationwide sampling plan developed for the USDA's National Food and Nutrient Analysis Program (NFNAP). Whole turkey parts; breast, back, thighs, drumsticks, wings and legs were removed from whole turkeys and weighed raw and cooked prior to homogenizing and compositing. Weights of meat, skin, and other components were obtained in order to determine cooking yields. Samples of meat, skin and offal (gizzard, heart, and liver) were homogenized, composited, and chemically analyzed for nutrient content.

Sample preparation: Separation of meat, skin, separable fat, cartilage, and bone- Each enhanced and non-enhanced turkey was cut into parts: breast, wings, drumsticks, thighs, and back including the tail. Each part was weighed and refrigerated for up to 24 hours. Dissection of each turkey part was performed by carefully "scraping" the co-mingled parts with a knife blade, so that the separable fat, bone, and cartilage were separated from the meat as closely as possible, then weighed to measure the amount of each component.

Component weights (i.e., weights of meat, skin, separable fat, bone, and cartilage) were reported in SR. Weights of bone and cartilage were combined and reported as "refuse". For food items listed as "meat only", the skin and separable fat associated with those cuts is included in the "refuse". For food items listed "meat and skin", the skin and separable fat are considered edible and thus contribute to the nutrient profile so are not included in the refuse.

Cooking Procedure: Roasting - Thawed turkey parts were unwrapped and weighed. The oven was preheated to 350^{o}F/176°C. The turkey parts were placed on a wire rack in a shallow roasting pan, with no water added to the pan. Thermocouples were placed

in the thickest portions of the pieces. The parts were roasted, uncovered, to an internal temperature of 165°F/74°C, when they were removed from the oven. After 30 minutes at room temperature, the cooked weights were obtained.

Sample composites and nutrient analyses: For each analytical sample, the turkey part purchased at each individual location was used to create an individual composite. For the drumsticks and wings, composites from each location were paired (n=4 or 6) then homogenized and analyzed in both raw and cooked forms. For the thighs and breast, each composite location (n=3 or 5) was homogenized and analyzed separately in both raw and cooked forms. Skin samples from the thigh and drumsticks were pooled and analyzed both in raw and cooked forms for the 'skin from dark meat' item. At this individual composite level, proximate nutrients (moisture, total fat, ash, and protein) and minerals were analyzed.

Samples from two or more locations were combined to form regional or national composites for these nutrients: cholesterol, fatty acids, thiamin, niacin, riboflavin, vitamin B6, vitamin B12, carotenoids, and retinol. Values for amino acids and choline were also obtained from regional composites. Nutrient analyses were performed by TTU and a commercial laboratory, whose analytical procedures were evaluated and validated through the NFNAP process.

As a result of this study, data have been generated to create new SR items for enhanced and non-enhanced turkey breast, drumsticks, thighs, back, wings and legs.

Enhanced and non-enhanced dark meat chicken

USDA conducted a study in collaboration with Texas Tech University to determine the nutrient composition of raw and cooked chicken drumsticks and thighs sold as retail parts, for inclusion in SR. Samples of non-enhanced dark meat chicken (n=7) and enhanced (n=7) were procured from 12 retail locations, using the nationwide sampling plan developed for the USDA's National Food and Nutrient Analysis Program (NFNAP). Two packages of thighs and drumsticks per location were purchased from retail stores —one to be dissected and analyzed raw and the other to be dissected and analyzed after roasting and braising. All of the chicken thighs and drumsticks were shipped to Texas Tech University for processing. Weights of meat, skin, and other components were obtained in order to determine cooking yields. Samples of meat and skin were homogenized separately, composited, and chemically analyzed for nutrient content.

Cooking Procedures:

Roasting - Chicken drumsticks and thighs were weighed. The oven was preheated to 350°F/176°C. The drumsticks and thighs were placed on a wire rack in a shallow roasting pan, with no water added to the pan. Thermocouples were placed in the thickest portions of the pieces. The drumsticks and thighs were roasted, uncovered, to an internal temperature of 165°F/74°C, when they were removed from the oven. After 30 minutes at room temperature, the cooked weights were obtained.

Braising - Oven was preheated to 325°F/ 163°C. The chicken drumsticks and thighs were weighed and placed on a roasting pan. Distilled water (100 ml) was added to the roasting pan, which was covered tightly and placed in the center of the oven. Cooking time was determined from initial trials. Initial cooking time estimates were 45 minutes for drumsticks and thighs. The internal temperature was determined with an electronic digital thermometer. Drumsticks and thighs were allowed to cool for 5 minutes and then re-weighed; weights were recorded.

Sample preparation: Separation of meat, skin, separable fat, cartilage, and bone: After weighing, the drumsticks and thighs were refrigerated for up to 24 hours. Dissection of each was performed by carefully scraping the co-mingled parts with a knife blade, so that the separable fat, bone, and cartilage were separated from the meat as closely as possible then weighed, to measure the amount of each component.

Component weights (i.e., weights of meat, skin, separable fat, bone, and cartilage) are reported in SR. Weights of bone and cartilage have been combined and reported as "refuse". For items listed as "meat only", the skin and separable fat associated with those cuts is included in the "refuse". For items listed as "meat and skin", the skin and separable fat are considered edible and thus contribute to the nutrient profile so are not included in the refuse.

Sample composites and nutrient analyses: For each analytical sample, the drumstick and thigh purchased at each individual location was used to create an individual composite. For the drumsticks and thighs, composites from each location were paired (n=4 or 6) then homogenized and analyzed in both raw and cooked forms. Skin samples from the thigh and drumsticks were pooled and analyzed both in raw and cooked forms for the "skin from dark meat" item. At this individual composite level, proximate nutrients (moisture, total fat, ash, and protein) and minerals were analyzed.

Samples from two or more locations were combined to form regional or national composites for these nutrients: cholesterol, fatty acids, thiamin, niacin, riboflavin, vitamin B6, vitamin B12, carotenoids, and retinol. Values for amino acids and choline were also obtained from regional composites. Nutrient analyses were performed by TTU and a commercial laboratory, whose analytical procedures were evaluated and validated through the NFNAP process.

As a result of this study, data have been generated to create new SR items for enhanced chicken drumsticks and thighs, non-enhanced chicken drumsticks and thighs plus skin.

Enhanced and non-enhanced light meat chicken study

USDA conducted a study in collaboration with Texas Tech University to determine the nutrient composition of raw and cooked enhanced and non-enhanced skinless, boneless chicken breast and wings with skin sold as retail parts, for inclusion in SR.

Samples of non-enhanced skinless, boneless breasts (n=12) and enhanced (n=12) plus non-enhanced chicken wings with skin (n=12) were procured from 12 retail locations, using the nationwide sampling plan developed for the USDA's National Food and Nutrient Analysis Program (NFNAP). A package of enhanced and non-enhanced breast and non-enhanced wings with skin per location were purchased from retail stores. Half of the package was dissected and analyzed raw and the other to be dissected and analyzed after roasting, braising and grilling. All of the chicken breasts and wings were shipped to Texas Tech University for processing. Weights of meat, skin, and other components were obtained in order to determine cooking yields. Samples of meat and skin were homogenized separately, composited, and chemically analyzed for nutrient content.

Cooking Procedures:

Roasting - Chicken wings with skin were weighed. The oven was preheated to 350°F/176°C. The wings were placed on a wire rack in a shallow roasting pan, with no water added to the pan. Thermocouples were placed in the thickest portions of the pieces. The wings were roasted, uncovered, to an internal temperature of 165°F/74°C, when they were removed from the oven. After 30 minutes at room temperature, the cooked weights were obtained.

Braising - Oven was preheated to 325°F/163°C. The chicken breasts were weighed and placed on a roasting pan. Distilled water (100 ml) was added to the roasting pan, which was covered tightly and placed in the center of the oven. Cooking time was determined from initial trials. Initial cooking time estimates were 45 minutes for the breasts. The internal temperature was determined with an electronic digital thermometer. Chicken breasts were allowed to cool for 5 minutes and then re-weighed; weights were recorded.

Sample composites and nutrient analyses: For each analytical sample, the chicken breast and wings purchased at each individual location was used to create an individual composite. For the breast and wings, composites from each location were paired (n=4 or 6) then homogenized and analyzed in both raw and cooked forms. At this individual composite level, proximate nutrients (moisture, total fat, ash, and protein) and minerals were analyzed.

Samples from two or more locations were combined to form regional or national composites for these nutrients: cholesterol, fatty acids, thiamin, niacin, riboflavin, vitamin B6, vitamin B12, carotenoids, and retinol. Values for amino acids and choline were also obtained from regional composites. Nutrient analyses were performed by TTU and a commercial laboratory, whose analytical procedures were evaluated and validated through the NFNAP process.

As a result of this study, data have been generated to create new SR items for enhanced and non-enhanced, boneless, skinless chicken breasts and wings with skin.

Ruffled Grouse and Canadian Goose

A study was conducted in collaboration with Cornell University to determine the nutrient composition of ruffed grouse (n=2) and Canadian goose species (n=2). Both of these species were obtained from different locations in Minnesota, New York, and Vermont. Protocols on field dressing, fabrication, and dissection were provided to Cornell University personnel, who oversaw the study. Weights for component factors such as separable lean, bone and connective tissue (refuse) were determined at Cornell University. Nutrient analysis for proximates, minerals and fatty acids on the edible meat were conducted at Texas Tech University. Nutrient values for raw meat without skin were added to SR for each of these species.

References for Notes on Foods – Poultry Products

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Merrill AL, Watt BK. Energy value of foods: Basis and derivation, revised. US Department of Agriculture, Agriculture Handbook 74, 1973.

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Vegetable and Vegetable Products (Food Group 11)

The sources of nutrient data for this food group include the scientific literature, analytical studies conducted by NDL and other government agencies, and the food industry. Since the inception of NFNAP (p. 52) in 1997, a few canned and frozen vegetables have also been sampled and analyzed. Data for raw and cooked vegetables, with the exception of the studies described below, for the most part, come from the scientific literature. In most cases, data for other canned and frozen vegetables were supplied by the food industry.

In 2000 and 2001 the Produce for Better Health Foundation collaborated with the Nutrient Data Laboratory (NDL) to sample and analyze 16 vegetables utilizing NFNAP protocols (p. 52). For most vegetables, samples were collected from retail outlets in 12 major metropolitan areas, once during the peak market season for the particular vegetable and once during the low market season. Four composites comprised of sample units from three locations each were prepared, and sent to the lab for analysis. A number of vegetables (tomatoes, potatoes, broccoli, and broccoli raab) were also analyzed both raw and prepared. In most cases, vegetables in the retail market are not identified by cultivar. However, for lettuce, red leaf, green leaf, iceberg, romaine, and butterhead types were sampled; for potatoes, russet, red and white types were sampled. Since 2002, additional data were obtained via NFNAP for other vegetables on FDA's list of the 20 most commonly consumed fruits, nuts and vegetables (FDA/DHHS, 2011).

In 2004 the Mushroom Council collaborated with NDL to update the data on several types of mushrooms (white, maitake, oyster, enoki, shiitake, crimini and portabella). These samples were also collected from retail outlets in 12 major metropolitan areas. They were composited into four composites of samples from three locations each, and sent to the labs for analysis. Samples of white and portabella mushrooms were also cooked before analysis. In 2009 additional analyses were conducted for vitamin D in the above listed mushrooms. Samples of morel and chanterelle mushrooms were also collected for the first time.

Data are presented for raw, canned, dehydrated, and frozen vegetables and vegetable products. When appropriate, data are presented for both the unprepared and the prepared forms of the food.

Nutrient data for different forms of a vegetable were not necessarily derived from the same sample. That is, a single sample of snap beans was not analyzed in each of the three forms: raw, canned, and frozen. The data were obtained from many sources and may represent different growing years, growing areas, cultivars, processing techniques, lengths and conditions of storage, laboratories, and possibly different methods of analysis. Therefore, in a comparison of different forms of a vegetable, nutritional differences should not be ascribed solely to the effect of processing or preparation methods.

Several factors such as natural variation, differences in postharvest handling and storage, and variations in the processing or preparation method may cause a processed or prepared form of a vegetable to have a higher nutrient content than the unprocessed or unprepared form. The differences in nutrient content between the combined solids and liquid portion and the drained solids portion of canned vegetables may not accurately reflect the amount in the drained liquid portion for the reasons stated above.

Ascorbic acid in fresh vegetables such as cabbage, lettuce, and squash is extremely unstable and is easily oxidized, particularly after chopping, cutting, or shredding. This can be similar to what occurs during the preparation of the samples for analysis. Ascorbic acid is found in foods in the reduced form, and can be converted reversibly to dehydroascorbic acid. Both the reduced and the dehydroascorbic acid forms have vitamin activity. Dehydroascorbic acid can be oxidized to diketogulonic acid, which has no vitamin activity.

Potatoes are frequently stored for many months, which may cause a decrease in ascorbic acid content. The values in the database reflect an average of several typical storage times used commercially.

The vitamin A content of vegetables such as carrots and sweet potatoes increases as they mature. Canned and frozen forms of carrots or sweet potatoes are often more mature than fresh forms, utilize different cultivars, and thus may have higher vitamin A values. Sweet potatoes have been bred in recent years to develop cultivars with deep orange—colored flesh, and have, at the same time, increased in their vitamin A content. Data collected for the database reflect the considerable variability between different samples due to natural variation and differences in methodology.

The carbohydrate content of starchy vegetables, such as sweet corn, varies with maturity, cultivar, and length of storage. As the kernels mature, moisture decreases and the carbohydrate content increases, causing a corresponding increase in calories.

A large portion of the total carbohydrates in globe or French artichokes and Jerusalem-artichokes may be inulin, a naturally occurring fructose polysaccharide, which is often measured by some analytical methods as dietary fiber. During storage, inulin is converted to available sugars (Watt and Merrill, 1963). Consequently, as the carbohydrates change with storage, the energy value also varies. The values in the tables are for the stored forms of artichokes and Jerusalem-artichokes.

Federal regulations (US Food and Drug Administration—Department of Health and Human Services, 2004) allow for the addition to canned vegetables of certain calcium salts as firming agents. The standards specify how much of these salts can be added. The addition of these salts is reflected in the values in the database.

Oxalic Acid.—Oxalic acid can combine with calcium and magnesium to form highly insoluble compounds which can make these minerals unavailable to the body. However, most foods do not contain enough oxalic acid to combine with a significant amount of

calcium or magnesium from the same food or from another source. Those foods that contain high amounts of oxalic acid usually contain sufficient calcium or magnesium to bind with all the oxalic acid in that food. Therefore, oxalic acid in these foods would not interfere with the calcium and magnesium availability of other foods in the diet. A table listing the oxalic acid content of some vegetables is available on NDL's Web site (USDA-ARS, 1984).

Sodium.—Sodium values for cooked vegetables in the database are presented separately for unsalted vegetables and for cooked vegetables with salt added. Since the sodium content of tap water varies according to location (0-39 mg/100 g), the sodium value of the cooked vegetable may be underestimated if the water supply naturally contains high amounts of sodium. It is difficult to estimate the amount of salt absorbed by vegetables during cooking. Sodium content of the cooked vegetable will depend on the amount of salt used in the cooking water and can be as high as vegetables with salt added during canning. Sodium values for cooked vegetables with added salt were calculated by adding the content from approximately 1/8 of a teaspoon of salt per 100 grams of vegetables or 236 mg of sodium to the sodium naturally occurring in the cooked vegetable with no salt added. Sodium values for canned vegetables are presented, both for product with salt added and salt not added.

Certain processing methods can cause increases in the sodium content of the vegetable or vegetable product. Some processed vegetables, such as canned, frozen, or dehydrated carrots, potatoes, sweet potatoes, and tomatoes are often lye peeled. The vegetable is dipped into a hot sodium hydroxide solution, followed by a water rinse. While the rinse will remove some of the sodium absorbed during the lye peeling operation, some will remain in the finished product.

Sodium compounds such as monosodium glutamate, disodium guanylate, and disodium inosinate may be added to some processed vegetable products as flavor enhancers. Sodium compounds may be added to potatoes to prevent browning during commercial processing. Lima beans and peas are brine sorted before blanching and freezing, which can result in the vegetables picking up sodium from the brine.

Nomenclature.— To aid in identifying individual vegetables listed in the tables, the scientific name of the vegetables is included in the food description file, usually on the raw form of the vegetable. The USDA Germplasm Resources Information Network (GRIN), (USDA, 2011) was used as the basic reference for the scientific and preferred common names. Identifying vegetables by their common names is often confusing because these names are not always applied to the same food in different geographic locations. Some names of vegetables in common use or unique to one region of the country have been indicated in the common name field of the food description file. In some cases, the usual nomenclature is particularly confusing. These are further explained in the following paragraphs.

Cassava (*Manihot esculenta*) is one of the major sources of carbohydrates for human food in many parts of the world and is also known as manioc or yuca. It is extensively

cultivated in tropical areas for its starchy, tuberous root. Cassava is sometimes called yucca, though this is a different plant. The yucca (*Yucca* spp.) is more frequently grown as an ornamental plant, though the fruits, flowers and flowering stem can be eaten. However, the root contains high levels of saponins, which are toxic.

Garden cress *(Lepidium sativum*) is a cultivated plant brought originally to this country from Europe. This plant often grows wild, and is called field cress in some areas.

Endive and chicory are often confused with each other. Cultivars of endive grown in the United States have the species name *Cichorium endivia,* and are quite different in structural appearance from Witloof chicory (*Cichonium intybus*), which is also known as French or Belgian endive. Endive (*Cichonium endivia*) is always marketed in the headed form, the larger heads weighing more than a pound. The heads are low—spreading and loose— leaved. The leaves vary from deeply cut and deeply curled in some cultivars to the broad, slightly cut and curled leaves of escarole. The outer leaves are green, and the center leaves or heart and the midribs are pale green to creamy white. Chicory is sometimes marketed as blanched heads, greens, or roots. Witloof chicory is commonly forced and can be identified by its very small, elongated, compact, well—blanched head, which resembles a small shoot and weighs about 2 ounces. Witloof chicory is also grown for greens.

The term yam is frequently used when referring to sweet potatoes in common usage and marketing. Sweet potatoes (*Ipomea batatas)* are elongated tubers with a white or orange—yellow colored flesh. The orange-yellow cultivars are commonly marketed in the United States. For the market, sweet potatoes are sometimes identified as yams. Raw, canned, and frozen sweet potatoes are sometimes identified on the label as yams. The true yam (*Dioscorea* spp.) is a tropical tuber. Yam cultivars may have white or pale—yellow flesh. In most areas of the United States, true yams are generally available only in certain specialty stores.

Raw vegetables.—Although nutrient data were available for several cultivars of some vegetables, the data base for any one cultivar was too small to justify giving separate entries by cultivar. Production data by cultivar were unavailable for most vegetables.

The values for raw potatoes listed in the tables were calculated from data for several cultivars and weighted as follows: Russet, 70 percent; White, 18 percent; and red, 12 percent.

Prepared vegetables.—Nutrient data on cooked vegetables were often unavailable or incomplete. In these cases, the appropriate nutrient values for the cooked form were calculated from the unprepared form of the same food. For example, nutrient data for cooked asparagus were calculated from data for raw asparagus. Appropriate true nutrient retention factors (NDL, 2007) were used to calculate the nutrient content of the cooked foods, after adjusting for changes in the moisture content of the uncooked foods. The same procedures were followed for the cooked, frozen vegetables.

Retention values are generally based on cooking methods that minimize the loss of nutrients, particularly the water soluble vitamins. Nutrient values of cooked vegetables obtained by these procedures tend to be higher than those values for the same vegetables cooked by less than optimum methods. Some conditions that affect the retention of nutrients in vegetables that are cooked include: Cooking method, size and shape of the vegetable or amount of surface area, maturity, condition of the vegetable, amount of cooking water, and length of cooking.

Nutrient values for vegetables prepared by microwave cooking would be similar to those obtained by conventional cooking methods, except where cooking times are lengthened because of the shape of the vegetable or the total amount of the vegetable that is cooked at one time. For example, one potato in a microwave oven will bake in approximately 5 minutes, while four potatoes will take four times longer. The ingredients and proportions used to calculate nutrient values for vegetable mixtures such as coleslaw, corn pudding, potato salad, spinach soufflé, and candied sweet potatoes are given in a footnote for each item. Values for each nutrient provided by the ingredients used in the recipe were totaled. Nutrient values were adjusted to account for any changes due to evaporation and heat destruction.

References for Notes on Foods – Vegetables and Vegetable Products

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Appendix A. Abbreviations Used in Short Descriptions

All purpose	ALLPURP
Aluminum	AL
And	&
Apple	APPL
Apples	APPLS
Applesauce	APPLSAUC
Approximate	APPROX
Approximately	APPROX
Arm and blade	ARM&BLD
Artificial	ART
Ascorbic acid	VIT C
Aspartame	ASPRT
Aspartame-sweetened	ASPRT-SWTND
Baby food	BABYFD
Baked	BKD
Barbequed	BBQ
Based	BSD
Beans	BNS
Beef	BF
Beverage	BEV
Boiled	BLD
Boneless	BNLESS
Bottled	BTLD
Bottom	BTTM
Braised	BRSD
Breakfast	BRKFST
Broiled	BRLD
Buttermilk	BTTRMLK
Calcium	CA
Calorie, calories	CAL
Canned	CND
Carbonated	CARB
Center	CNTR
Cereal	CRL
Cheese	CHS
Chicken	CHICK
Chocolate	CHOC
Choice	CHOIC
Cholesterol	CHOL
Cholesterol-free	CHOL-FREE
Chopped	CHOPD
Cinnamon	CINN

Coated	COATD
Coconut	COCNT
Commercial	COMM
Commercially	COMMLY
Commodity	CMDTY
Composite	COMP
Concentrate	CONC
Concentrated	CONCD
Condensed	COND
Condiment, condiments	CONDMNT
Cooked	CKD
Cottonseed	CTTNSD
Cream	CRM
Creamed	CRMD
Dark	DK
Decorticated	DECORT
Dehydrated	DEHYD
Dessert, desserts	DSSRT
Diluted	DIL
Domestic	DOM
Drained	DRND
Dressing	DRSNG
Drink	DRK
Drumstick	DRUMSTK
English	ENG
Enriched	ENR
Equal	EQ
Evaporated	EVAP
Except	XCPT
Extra	EX
Flank steak	FLANKSTK
Flavored	FLAV
Flour	FLR
Food	FD
Fortified	FORT
French fried	FRENCH FR
French fries	FRENCH FR
Fresh	FRSH
Frosted	FRSTD
Frosting	FRSTNG
Frozen	FRZ
Grades	GRDS
Gram	GM
Green	GRN
Greens	GRNS
Heated	HTD

Heavy	HVY
Hi-meat	HI-MT
High	HI
Hour	HR
Hydrogenated	HYDR
Imitation	IMITN
Immature	IMMAT
Imported	IMP
Include, includes	INCL
Including	INCL
Infant formula	INF FORMULA
Ingredient	ING
Instant	INST
Juice	JUC
Junior	JR
Kernels	KRNLS
Large	LRG
Lean	LN
Lean only	LN
Leavened	LVND
Light	LT
Liquid	LIQ
Low	LO
Low fat	LOFAT
Marshmallow	MARSHMLLW
Mashed	MSHD
Mayonnaise	MAYO
Medium	MED
Mesquite	MESQ
Minutes	MIN
Mixed	MXD
Moisture	MOIST
Natural	NAT
New Zealand	NZ
Noncarbonated	NONCARB
Nonfat dry milk	NFDM
Nonfat dry milk solids	NFDMS
Nonfat milk solids	NFMS
Not Further Specified	NFS
Nutrients	NUTR
Nutrition	NUTR
Ounce	OZ
Pack	PK
Par fried	PAR FR
Parboiled	PARBLD
Partial	PART

Partially	PART
Partially fried	PAR FR
Pasteurized	PAST
Peanut	PNUT
Peanuts	PNUTS
Phosphate	PO4
Phosphorus	P
Pineapple	PNAPPL
Plain	PLN
Porterhouse	PRTRHS
Potassium	K
Powder	PDR
Powdered	PDR
Precooked	PRECKD
Preheated	PREHTD
Prepared	PREP
Processed	PROC
Product code	PROD CD
Propionate	PROP
Protein	PROT
Pudding, puddings	PUDD
Ready-to-bake	RTB
Ready-to-cook	RTC
Ready-to-drink	RTD
Ready-to-eat	RTE
Ready-to-feed	RTF
Ready-to-heat	RTH
Ready-to-serve	RTS
Ready-to-use	RTU
Reconstituted	RECON
Reduced	RED
Reduced-calorie	RED-CAL
Refrigerated	REFR
Regular	REG
Reheated	REHTD
Replacement	REPLCMNT
Restaurant-prepared	REST-PREP
Retail	RTL
Roast	RST
Roasted	RSTD
Round	RND
Sandwich	SNDWCH
Sauce	SAU
Scalloped	SCALLPD
Scrambled	SCRMBLD
Seed	SD

Select	SEL
Separable[1]	
Shank and sirloin	SHK&SIRL
Short	SHRT
Shoulder	SHLDR
Simmered	SIMMRD
Skin	SKN
Small	SML
Sodium	NA
Solids	SOL
Solution	SOLN
Soybean	SOYBN
Special	SPL
Species	SP
Spread	SPRD
Standard	STD
Steamed	STMD
Stewed	STWD
Stick	STK
Sticks	STKS
Strained	STR
Substitute	SUB
Summer	SMMR
Supplement	SUPP
Sweet	SWT
Sweetened	SWTND
Sweetener	SWTNR
Teaspoon	TSP
Thousand	1000
Toasted	TSTD
Toddler	TODD
Trimmed[1]	
Trimmed to[1]	
Uncooked	UNCKD
Uncreamed	UNCRMD
Undiluted	UNDIL
Unenriched	UNENR
Unheated	UNHTD
Unprepared	UNPREP
Unspecified	UNSPEC
Unsweetened	UNSWTND
Variety, varieties	VAR
Vegetable, vegetables	VEG
Vitamin A	VIT A
Vitamin C	VIT C
Water	H20

Whitener	WHTNR
Whole	WHL
Winter	WNTR
With	W/
Without	WO/
Yellow	YEL

[1] Removed in short description

Appendix B. Other Abbreviations

ap	as purchased
ARS	Agricultural Research Service
DFE	Dietary Folate Equivalent
dia	diameter
DRI	Dietary Reference Intakes
fl oz	fluid ounce
FNDDS	USDA Food and Nutrient Database for Dietary Studies
g	gram
INFOODS	International Network of Food Data Systems
IU	International Unit
kcal	kilocalorie
kJ	kilojoule
lb	pound
mg	milligram
µg, mcg	microgram
ml	milliliter
NDB	Nutrient Databank
NDBS	Nutrient Databank System
NDL	Nutrient Data Laboratory
NFNAP	National Food and Nutrient Analysis Program
NLEA	Nutrition Labeling and Education Act
oz	ounce
RAE	Retinol Activity Equivalent
RE	Retinol Equivalents
RDA	Recommended Dietary Allowances, a Dietary Reference Intake
SR	USDA National Nutrient Database for Standard Reference
UL	Tolerable Upper Intake Level, a Dietary Reference Intake

Appendix C. Cooking Glossary for Meat and Poultry Items

- **Baked or Roasted:** Food cooked uncovered in an oven with no liquid added, thereby surrounding it with dry heat
- **Braised:** Food cooked on top of the range or in the oven, tightly covered in a small amount of liquid at low heat for a lengthy period of time.
- **Broiled or Grilled:** Food cooked directly under or above the heat source. Food can be broiled in an oven under a gas or electric heat source, or grilled directly over charcoal or other heat source. The term “barbecued” is sometimes used synonymously with grilled.
- **Dry heat:** A cooking technique in which heat is transferred to the food without the use of a liquid. Examples of dry heat techniques are baking, roasting, and grilling.
- **Fast Fried:** Food cooked in uncovered skillet at moderate to high heat, 3-4 minutes per side depending on thickness of the cut.
- **Fast Roasted:** Food roasted or fan-baked in an oven, such as a convection oven, for a short time at high temperature (approximately 15 minutes/500g piece of meat).
- **Fried in deep fat or oil**: Food which is cooked by immersing in hot fat or oil deep enough to completely cover the food being cooked. Average fat temperature for deep frying is 375°F/190°C, but a recipe may specify a different temperature, according to the characteristics of the food.
- **Microwaved**: Food heated or cooked using a specific type of oven that produces high frequency electromagnetic radiation as the heat source.
- **Moist heat**: A cooking technique in which heat is transferred to the food by using liquid or steam. Examples of moist heat techniques are braising, simmering, and steaming.
- **Pan-fried (fried in pan), Sautéed, or Stir fried:** Food cooked in fat which does not cover the food. Sautéing is often used to describe a method which is faster and uses less fat than pan-frying. Stir-frying is to quickly cook small pieces of food in a pan with a large surface area, using a minimum amount of fat and very high heat, while constantly stirring the food.
- **Pan-broiled:** Food cooked in uncovered skillet or frying pan over direct heat, using little or no fat. Drippings are poured off as they form.
- **Pan-browned:** Food cooked in uncovered skillet or frying pan over direct heat to obtain a brown surface on the food.
- **Poached, Simmered, or Stewed:** Food cooked in liquid at a temperature low enough that tiny bubbles just begin to break the surface (~185°F/85°C). A food being stewed involves simmering for a long period of time in a tightly covered pot.
- **Raw**: Food item in its natural state: not processed, refined, or cooked.
- **Slow Roasted:** Food roasted or fan-baked in an oven, such as a convection oven, for approximately 25-30 minutes/500g piece of meat.
- **Thawed**: Frozen food that has been exposed to a temperature higher than freezing so that it has defrosted and reached a softened state.

Appendix D. Imputing Less Than Measurements

Prepared by: Charles R. Perry, Jr. and Daniel G. Beckler, For: the Nutrient Data Laboratory, Agricultural Research Service, United States Department of Agriculture

Nutrient analysis techniques sometimes result in a less than value being reported to NDL or in the scientific literature. Such values are usually identified as either *less than the limit of quantification*, or *less than the limit of detection*. This paper presents a coherent set of rules for imputing these *less than* measurement.

NDL also considered the possibility of applying different imputation methods for nutrients that have positive dietary effects and those that have negative dietary effects. However, it is not always clear how to differentiate which nutrients are positive and those that are negative. This is complicated by the fact that certain nutrients have positive dietary effects only when they are present in very limited quantities. The working paper *Imputing Values for Trace and Not Detected Measurements* by Perry and Beckler contain separate imputation methods for positive and negative nutrients. NDL may readdress the merit of using different imputation strategies at a later date when more nutrient information is known.

There are three basic assumptions at work:

Let: *C* be the lower limit of the amount that can be present, *D* be the limit of detection (LOD), and *Q* be the limit of quantification (LOQ).

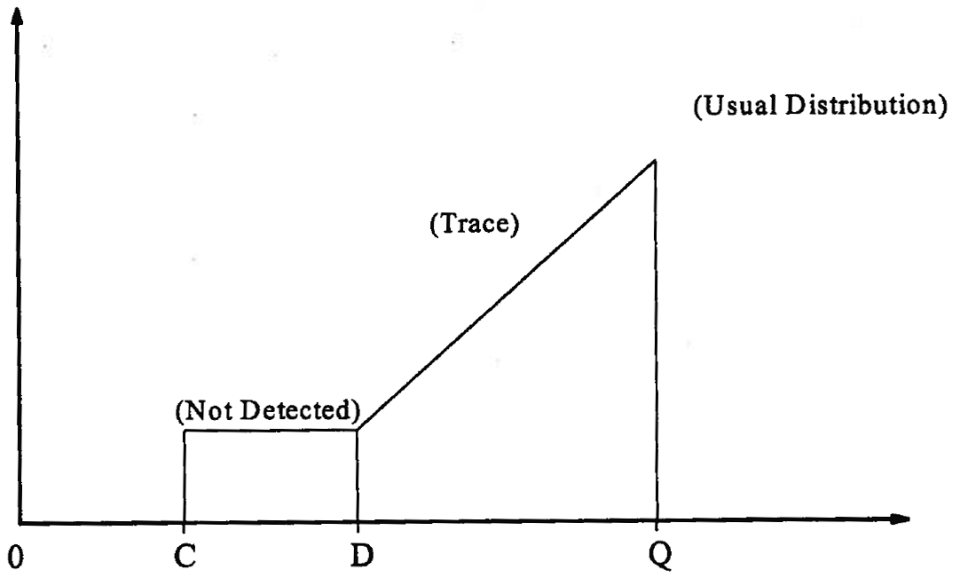

Figure 1: Assumed Distribution of Amount Present

Assumption 1: When we detect less than the limit of quantification amounts, we assume that our ability to detect the chemical is proportional to the amount present. This implies that the actual amount present T has a triangular distribution from limit of detection to the limit of quantification. Thus, we are lead to impute less than the limit of quantification amounts as:

a. $\sqrt{\frac{D^2+Q^2}{2}}$, the median of the triangular distribution over D to Q when Q and D are known;

b. $\sqrt{\frac{C^2+Q^2}{2}}$, the median of the triangular distribution over C to Q when Q and C are known and D is unknown, and

c. $\sqrt{\frac{0^2+Q^2}{2}}$, the median of the triangular distribution over 0 to Q when Q is known and C and D are unknown.

Assumption 2. When the analysis process indicates the amount of the nutrient present is less than the limit of detection, we assume that the actual amount present, T, is equally likely to be located at any point in the range of values where the actual values are known to lie. This implies that the actual amount present, T, has a uniform distribution from the lower limit of the amount present to the limit of detection. Thus, we are lead to impute less than the limit of detection amounts as:

a. $\frac{C+D}{2}$, the median of the uniform distribution over C to D when C and D are known;

b. $\frac{0+D}{2}$ the median of the uniform distribution over O to D when C is unknown and D is known;

c. $\frac{C+C}{2}$ = C when C is known and D is unknown;

d. $\frac{0+0}{2}$ = 0 when C and D are both unknown.

Assumption 3: When the limit of quantification is not known for a set of measurements, we first impute it from the current data measurements (or from a similar set of measurements) by assuming its actual value is uniformly distributed between its maximum likelihood estimate from the current measurements, min(current quantifiable values), and the next lower value that is known. That is:

a. $Q = \frac{1}{2}(\min(\text{current measurements}) + D)$, when D is known;

b. $Q = \frac{1}{2}(\min(\text{current measurements}) + C)$, when D is unknown and C is known;

c. $Q = \frac{1}{2}\min(\text{current measurements})$, when both C and D are unknown.

This approach to imputing missing Q is likely to be somewhat conservative and result in a lower values for Q than the actual limit of quantification.

We can summarize the decision rules for imputation that result from the above assumptions as follows:

Case 1: C, D and Q are known	**Impute Trace As:**	**Impute Not Detected As:**
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{C + D}{2}$

Case 2: D & Q known, C unknown	**Impute Trace As:**	**Impute Not Detected As:**
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{0 + D}{2}$

Case 3: C & Q known, D unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{C^2 + Q^2}{2}}$	C

Case 4: Q known, C & D unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{0^2 + Q^2}{2}}$	0

Case 5: C & D known, Q unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{C + D}{2}$

Case 6: D known, Q &C unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{0 + D}{2}$

Case 7: C known, D & Q unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{C^2 + Q^2}{2}}$	C

Case 8: D, Q & C unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{0^2 + Q^2}{2}}$	0

References for Appendix D

Gelman A, Carlin JB, Stern HS, Rubin DB. Bayesian data analysis. London: Chap & Hall. 1995.

Little RA, Rubin DB. Statistical analysis with missing data. Hoboken, NJ: John Wiley and Sons. 2002.

Rubin DB. Multiple imputation for nonresponse surveys. Hoboken, NJ: John Wiley and Sons. 1987.

Appendix E. Imputing Values for Trace and Not Detected Measurements.

Prepared by: Charles R. Perry, Jr. and Daniel G. Beckler for Nutrient Data Laboratory, Agricultural Research Service, United States Department Of Agriculture

Nutrient analysis techniques sometimes result in a trace or undetectable amounts being reported to NDL or in the scientific literature. This paper presents a coherent set of rules for imputing when the measurement is either a trace or not detected.

There are three basic assumptions at work:

Let: *C,* be the lower limit of the amount that can be present; D*,* be the limit of detection and *Q* be the limit of quantification.

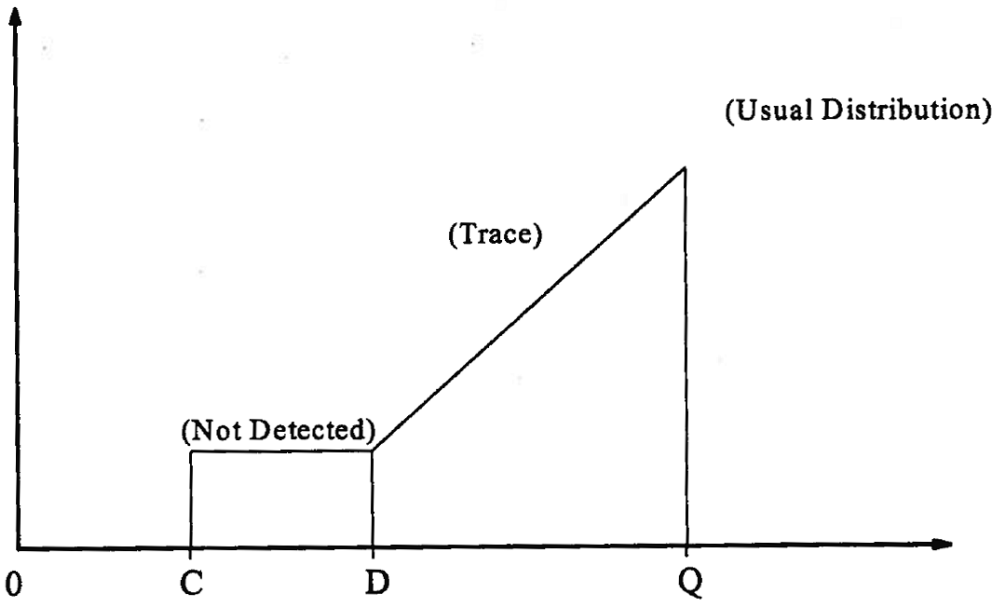

Figure 1: Assumed Distribution of Amount Present

Assumption 1: When we detect a trace, we assume that our ability to detect the chemical is proportional to the amount present. This implies that the actual amount present T has a triangular distribution from limit of detection to the limit of quantification. Also, since the dietary effect of a nutrient can be either positive or negative, we are lead to act conservatively and impute trace measurements conditionally on the nutrient's dietary effect.

When the dietary effect of more of the nutrient is positive, trace measurements should be imputed as:

a. $\sqrt{\frac{D^2 + Q^2}{2}}$, the median of the triangular distribution over D to Q when Q and D are known;

b. $\sqrt{\frac{C^2 + Q^2}{2}}$, the median of the triangular distribution over C to Q when Q and C are known and D is unknown, and

c. $\sqrt{\frac{0^2 + Q^2}{2}}$, the median of the triangular distribution over 0 to Q when Q is known and C and D are unknown.

When the dietary effect of less of the nutrient is positive, trace measurements should be imputed as:

a. $\sqrt{\frac{D^2 + Q^2}{2}}$, when Q and D are known;

b. Q, when Q and C are known and D is unknown, and

c. Q, when Q is known and C and D are unknown.

Assumption 2. When we do not detect the chemical, we assume that the actual amount present, T, is equally likely to be located at any point in the range of values where the actual values are known to lie. This implies that the actual amount present, T, has a uniform distribution from the lower limit of the amount present to the limit of detection.

When the dietary effect of more of the nutrient is positive, trace measurements should be imputed as:

a. $\frac{C + D}{2}$, the median of the uniform distribution over C to D when C and D are known;

b. $\frac{0+D}{2}$ the median of the uniform distribution over O to D when C is unknown and D is known;

c. $\frac{C+C}{2}$ = C when C is known and D is unknown;

d. $\frac{0+0}{2}$ = 0 when C and D are both unknown.

When the dietary effect of less of the nutrient is positive, trace measurements should be imputed as:

a. $\frac{C+D}{2}$, when C and D are known;

b. D, when C is unknown and D is known;

c. $\frac{C+Q}{2}$, when C is known and D is unknown;

d. Q, when C and D are both unknown.

Assumption 3: When the limit of quantitation is not known for a set of measurements, we first impute it from the current data measurements (or from a similar set of measurements) by assuming its actual value is uniformly distributed between its maximum likelihood estimate from the current measurements, min(current quantitation values), and the next lower value that is known.

When the dietary effect of more of the nutrient is positive, trace measurements should be imputed as:

a. $Q = \frac{1}{2}(\min(\text{current measurements}) + D)$, when D is known;

b. $Q = \frac{1}{2}(\min(\text{current measurements}) + C)$, when D is unknown and C is known;

c. $Q = \frac{1}{2}\min(\text{current measurements})$, when both C and D are unknown.

When the dietary effect of less of the nutrient is positive, trace measurements should be imputed as: $Q = \min(\text{current measurements})$, regardless of knowledge C and D.

These approaches to imputing missing Q are likely to be somewhat conservative and result in lower values for Q than the actual limit of quantification when the nutrient's effect is positive and larger values of Q than the actual limit when the nutrient's effect is negative.

We can summarize the decision rules for imputation that result from the above assumptions as follows:

Case 1: C, D and Q are known	**Impute Trace As:**	**Impute Not Detected As:**
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{C + D}{2}$
When *Less* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{C + D}{2}$

Case 2: D & Q known, C unknown	**Impute Trace As:**	**Impute Not Detected As:**
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{0 + D}{2}$
When *Less* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	D

Case 3: C & Q known, D unknown	**Impute Trace As:**	**Impute Not Detected As:**
When *More* is Better:	$\sqrt{\frac{C^2 + Q^2}{2}}$	C
When *Less* is Better:	Q	$\frac{C + Q}{2}$

Case 4: Q known, C & D unknown	**Impute Trace As:**	**Impute Not Detected As:**
When *More* is Better:	$\sqrt{\frac{0^2 + Q^2}{2}}$	0
When *Less* is Better:	Q	Q

Case 5: C & D known, Q unknown	**Impute Trace As:**	**Impute Not Detected As:**
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{C + D}{2}$
When *Less* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{C + D}{2}$

Case 6: D known, Q &C unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	$\frac{0 + D}{2}$
When *Less* is Better:	$\sqrt{\frac{D^2 + Q^2}{2}}$	D

Case 7: C known, D & Q unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{C^2 + Q^2}{2}}$	C
When *Less* is Better:	Q	$\frac{C + Q}{2}$

Case 8: D, Q & C unknown	Impute Trace As:	Impute Not Detected As:
When *More* is Better:	$\sqrt{\frac{0^2 + Q^2}{2}}$	0
When *Less* is Better:	Q	Q

However, there are some nutrients that have positive dietary effects when they are present in a certain range of quantities and have negative dietary effects when they are present in levels outside that range. For such nutrients the following procedure is recommended:

1. If other available data for the nutrient are towards the minimum of the beneficial

range, follow the procedures for imputing for “More is Better” nutrients.

2. If other available data for the nutrient are towards the maximum of the beneficial range, follow the procedures for imputing for “Less is Better” nutrients.

3. If other available data for the nutrient are distributed throughout the beneficial range impute twice, once with the “More is Better” method, and another time with the “Less is Better” method. Use the average of the two values for imputation.

References for Appendix E

Gelman A, Carlin JB, Stern HS, Rubin DB. Bayesian data analysis. London: Chap & Hall. 1995.

Little RA, Rubin DB. Statistical analysis with missing data. Hoboken, NJ: John Wiley and Sons. 2002.

Rubin DB. Multiple imputation for nonresponse surveys. Hoboken, NJ: John Wiley and Sons. 1987.