# 34th National Nutrient Databank Conference

*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*

**12-14 July 2010, Grand Forks, North Dakota**

## BOOK OF ABSTRACTS - ORAL

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# DEVELOPMENT OF A VITAMIN D DATBASE FOR NATIONAL NUTRITION MONITORING

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**Background and Objective**: There are many knowledge gaps in the study of vitamin D, including lack of intake patterns from national monitoring. To address this need, vitamin D values were developed for over 7,000 foods in the Food and Nutrient Database for Dietary Studies, 3.0 (FNDDS). The FNDDS, the technical database used for analyzing dietary intakes in What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2005-2006, is based on the USDA's National Nutrient Database for Standard Reference (SR). The SR was recently updated to include vitamin D values for about 4500 foods. About a third of the foods in the FNDDS are linked directly to single SR items (e.g., raw apple). The other items are multi-component foods for which the nutrients are derived by recipe calculations using data from SR for ingredients.
**Description**: The challenges in determining vitamin D content of these foods and how the values are derived from SR will be discussed. Further, the database was then applied to food intake data from 8437 males and females, ages 1 year and older from WWEIA, NHANES 2005-2006 to estimate usual intakes of vitamin D and compare them to the Dietary Reference Intakes.
**Conclusion:** The mean (SE) intakes was 5.0 (0.12) mcg/day. About one-third of individuals 1 year and over met their AI. The vitamin D database provides researchers with a tool to assess vitamin D intake patterns, identify foods that are major contributors, and investigate diet-disease relationships for U.S. populations.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# A COMPARISION OF THE NUTRIENT CONTENT OF HAWAIIAN FRUITS AND VEGETABLES WITH USDA STANDARD REFERENCE DATA

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**Objective:** To determine whether locally grown varieties of fruits and vegetables have large differences in nutrient content when compared with nationally available varieties.
**Materials and Methods**: Samples of 25 local varieties of fruits and vegetables were collected in Hawaii and analyzed for proximates and 14 micronutrients using AOAC methods. These values were then compared to USDA Standard Reference, Release 20.
**Results**: Nutrient content per 100 grams for the following raw fruits and vegetables are compared between local varieties and national data • Avocado: Local vs. Hass. Local varieties have higher fat and iron content, but lower potassium content. • Banana: Local vs. national. Local bananas do not differ significantly in protein or potassium content, have higher iron content, and slightly lower potassium content. • Cucumber: Japanese vs. national. Japanese variety has higher protein content, but lower phosphorous and potassium content. • Eggplant: Japanese vs. round. Japanese and round varieties have small differences in protein, phosphorous, potassium, magnesium, manganese, and zinc content. • Lettuce: Manoa vs. butter. Manoa lettuce has higher potassium content and lower phosphorous, calcium, and iron content. • Onions: Maui vs. yellow. Maui onions have lower protein, potassium, calcium, manganese content.
**Significance**: For some foods, it is important to distinguish between local and national varieties of fruits and vegetables. For these foods, we will carry both local and national varieties in our food composition table.

**Funding**: State of Hawaii, Department of Health, Contract ASO Log No. 03-220. Healthy Living Hawaii. Rachel Novotny (PI); HawaiiFoods. Sylvia Yuen (PI).

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# PRODUCTION OF UNIQUE SE-ENRICHED PRODUCTS AND BIOFUELS FROM PLANTS USED FOR REMOVING SELENIUM FROM THE SOIL

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**Objective:** In the Westside of California's San Joaquin Valley, we are initially using a plant-based strategy (phytomanagement) to remove selenium (Se) from naturally contaminated soils and then producing unique Se-enriched products after harvest of plant parts.
**Materials and Methods**: In its broadest sense this strategy uses plants, e.g., mustard, canola, cactus, to manage soluble Se by accumulating, volatilizing, stabilizing, and degrading Se in contaminated water and soils. After harvest of plant parts, we are processing seed for biofuel and creating Se-enriched meals and food products. We are initiating the speciation of Se in seeds, fruit, and skin.
**Results:** Our results demonstrated that plants grown on Se-tainted soils produce Se-enriched plant and seed food and feed products for human and animal consumption, while managing the soluble Se content in the soil via accumulation and volatilization. Selenium is often measured as selenomethionine in plant parts.
**Significance**: Coupling phytomanagement of Se-contaminated soils with the production of Se-biofortified plant products and biofuels, may provide central California growers a unique marketing opportunity while cleaning the soils with plants.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# FROM PLATE TO MARKET: A NOVEL APPROACH TO CONVERT FOODS CONSUMED BACK TO FOOD COMMODITIES

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**Background:** Currently, there is no national database that converts foods consumed in the national dietary surveys back to their respective amounts of food commodities. Food Intakes As Retail Commodities (FIARC) database, developed through a joint effort by USDA's Agricultural Research Service and Economic Research Service, serves this purpose. The objective was to develop FIARC databases for foods reported in What We Eat In America surveys from1994-2002.
**Methods:** There are two major steps in FIARC development: (1) foods reported consumed in the surveys are separated into their ingredients where necessary and assigned to an appropriate commodity and (2) conversion factors are applied to adjust for food processing losses to convert foods back to commodities.
**Results**: There are 8 major commodity categories in FIARC: dairy; fruits; grains; nuts; caloric sweeteners; fats and oils; vegetables and legumes; and meat, fish, poultry and eggs. Because each has several components, FIARC has 65 food commodities in total. The average amounts of commodities estimated from food intakes of persons aged ≥2y showed that of the total fruit commodity, 42% were oranges, 16% apples, and 7% were bananas. Potatoes contributed 26%, total brassica 5%, and total leafy vegetables 6% of total vegetable commodity. The major components of total meat, poultry and fish commodity were 44% beef and 34% chicken.
**Significance**: The advantages to converting food consumption data back to commodities would enable estimation of commodities that are actually consumed by different socio-economic population groups. FIARC is useful for nutrition and agricultural policy development. Funded by ARS & ERS, USDA

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# REPORT ON THE VITAMIN D CONTENT OF FORTIFIED RETAIL ORANGE JUICE IN THE U.S.

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Samples of vitamin D fortified orange juice obtained from retail food stores were analyzed for vitamin D3 content using a method developed by combining the best features of two AOAC officially approved methods. Detection by ultraviolet absorption at 265 nm was compared to detection by selected ion monitoring (SIM) using atmospheric pressure chemical ionization (APCI) mass spectrometry (MS). Furthermore, an ion trap (IT) mass spectrometer was employed in a dual parallel MS arrangement. The method was applied to 33 samples of 3 national orange juice brands and 7 samples of 5 other brands. The levels determined were compared to the label values, which corresponded to FDA allowed levels. All but one brand exceeded the label amounts. Vitamin D3 values ranged from 1.071 µg/100g (43 IU/100g) to 1.663 µg/100g (67 IU/100g), with an average across 55 samples analyzed, including duplicates, of 1.433 ± 0.114 µg/100g (57.31 ± 4.58 IU/100g). The average of the 38 uniquely identified samples, using the averages of duplicate sets, was 1.415 ± 0.122 µg/100g (56.62 ± 4.88 IU/100g), indicating that a typical 8 oz. glass of orange juice provided 3.397 ± 0.293 µg/100g (135.9 ± 11.7 IU/100g) vitamin D3. Only one store brand out of 39 fortified retail samples was labeled as fortified, but found not to contain vitamin D3.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# SIX SIGMA SCALE AS QUALITY CRITERIA FOR AGGREGATION OF FOOD PROPERTY MEASURES

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**Objective:** The CEN/TC standard 387 Food Composition Data Structure is the most recent feature, in Europe, to guarantee the harmonization of compilation processes among national Food Composition Data Banks. However procedures for aggregation of values are still under debate. The aim of this work is to assess the adequacy of six sigma quality techniques to aggregate values.
**Materials and Methods:** Data Quality Assessment System (DQAS) was used to select values for aggregation. Method Evaluation Decision Charts (MEDx) were used to support and improve the decision making when evaluating values from different sources. Six sigma strategy was applied to quantify the laboratory's test performance on the sigma scale. The combination of both methodologies was used as criteria for aggregation of laboratory values and data from literature.
**Results:** The approach was applied directly on laboratory data obtained for determination of sodium content in bread. Data from literature was selected according to the results of DQAS. The MEDx chart was constructed by representing the allowable inaccuracy and allowable imprecision. Sigma methodologies originate four possible performance classifications according to the region where the differences fall. From top to bottom aggregation was classified as: poor, marginal, good or excellent. Significance Six Sigma and MEDx are suited techniques able to refine the quality techniques already in place and take them to the next level of improvement.

**Funding:**This work was completed on behalf of the EuroFIR Consortium and funded under the EU 6th Framework Food Quality and Safety Program, Contract No. FOOD-CT-2005-513944

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# THE STORY IS NOT OVER ON DIETARY FIBER: AOAC INTERNATIONAL OFFICIAL METHODOLOGY FOR THE CODEX ALIMENTARIUS DEFINITION OF DIETARY FIBER

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Recently AOAC International adopted Official Method of Analysis (AOAC 2009.01) for Total Dietary Fiber (CODEX Definition) in Foods to quantitate the component of food elucidated by the CODEX Alimentarius Commission in ALINORM 9/32/26. Official Method 2009.01 includes resistant starch and oligosaccharides in the quantitation, components that were previously measured separately; potentially resulting in higher DF content values for some foods. In addition, the effects of processing may impact the final DF number for a variety of products. While this should reduce the confusion in labeling previously associated with low level DF products, it means that those building databases and carrying out research and development on DF must be alert to the DF methods used for quantitation.

Since Hippsley in 1953 coined the term ‘dietary fibre” for the digestion resistant components of foods, efforts have been made to concisely define DF and consequent analyze it in food. Trowell etal. (early 1970’s) offered a definition that became the international gold standard by the early 1980s, AOAC 985.29 was then developed to match the definition. Subsequent research surfaced additional DF components requiring specific Official Methods; however, a comprehensive method was not available. CCNFSDU passed a recommendation (Nov 2008, ALINORM 9/32/26) that CAC adopt an international definition for dietary fiber, an action taken by the CAC July, 2009 (ALINORM 9/32/REP); Official Method 2009.01 followed in October. Key events in the adoption of the definition, the commensurate method, and differences between previous and the updated method will be presented.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# NEW DEVELOPMENTS IN FEDERAL DIETARY SUPPLEMENT DATABASES

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**Background:** Dietary supplements are used by >50% of US adults. They provide substantial amounts of essential nutrients and other bioactive food components. Researchers need databases that catalog the presence and amounts of ingredients in these products.
**Objective:** Describe critical elements and challenges in developing analytical or label-based dietary supplement databases with federal collaborative efforts.
**Description:** An ODS-led federal working group in collaboration with USDA has developed the Dietary Supplement Ingredient Database (DSID) containing values verified by chemical analysis of representative adult multivitamin-mineral supplements. Childrens' and prenatal multivitamin mineral supplements, supplements containing long chain fatty acids, and eventually botanicals of public health significance will also be evaluated, as time and resources permit. Challenges in prioritization, sampling and analysis will be discussed. A dietary supplement label database (DSLD) for research is also being developed in collaboration with the group and National Library of Medicine. The goal is to include labels of virtually all dietary supplements marketed in the US. System requirements and prototype software are developed, a pilot study is completed, systematic description of supplements in DSLD using an adaptation of the Langual factored food vocabulary is being explored, and plans to populate the database are progressing. ODS and NCHS are collaborating to develop NHANES dietary supplement label survey database into a form that can be used by researchers. **Conclusion:** The availability of dietary supplement databases will make it possible to estimate total nutrient intakes of Americans more precisely than is currently possible.
**Funding:** ODS and collaborative efforts of several federal agencies

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# OBTAINING THE INFORMATION NECESSARY TO ADAPT THE U.S. DEPARTMENT OF AGRICULTURE'S AUTOMATED MULTIPLE PASS METHOD FOR USE WITH A NATIVE AMERICAN POPULATION

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**Background:** The Upper Columbia River Resources Survey is being conducted by the Colville Confederated Tribes (CCT) and the US Environmental Protection Agency (EPA) to quantify exposures to local resources (i.e., foods, herbs, medicines, and materials used in clothing, ornaments, and infrastructure). To assess usual food intake, four 24-hour dietary recalls will be conducted with study participants and coded using USDA's Automated Multiple Pass Method (AMPM) and SurveyNet systems.
**Objective:** To obtain the information necessary to customize the AMPM database to be inclusive of plants and animals commonly gathered or hunted for food in areas near the CCT reservation in eastern Washington State.
**Description:** Environment International (EI) researched available ethnobotanical literature and interviewed three CCT members with expertise and knowledge of traditional foodways. The interviews were open-ended and loosely structured in order to obtain information about species, parts, and common preparations of traditional foods. An internationally-renowned botanist from the University of British Columbia also contributed input to help resolve the species identification of plants. Westat used this information to expand the AMPM Main Food List to include these indigenous foods, and worked with EI to identify AMPM question paths that would be appropriate and intelligible to survey respondents.
**Conclusion:** The information required to construct a representative list of indigenous foods commonly consumed by CCT members for inclusion in the AMPM database can be captured by interviewing relatively few key informants.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# AN OVERVIEW OF THE NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY DIETARY SUPPLEMENTS DATABASE AND NEW DIETARY SUPPLEMENT 24 HOUR DIETARY RECALL COLLECTION

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**Background**: Nutrient intake is associated with a wide range of health and disease conditions. Most commonly, these relationships are based on intake of nutrients from foods only. Data from NHANES 2005-2006 indicate that 54% of adults 20 years and older took at least 1 dietary supplement (DS) in the past 30 days. The levels of many nutrients in these products are 100% or more of the Dietary Recommended Intake values. Previously in NHANES, methods of collection differed for DS and food intake data. Because of different data collection methods, referent time periods, and public release data files, these data require some modifications and assumptions to combine and therefore may not provide a very accurate estimate of daily total nutrient intake.
**Objective**: To present information on the new DS data available from NHANES.
**Description**: Since 1999, NHANES has collected data on use of DSs in the past 30 days as part of the interview-administered household questionnaire. Beginning in 2007, DS use is collected as part of the 24-hour dietary recall interviews. The first dietary recall interview is collected in-person in the Mobile Examination Center and the second interview is collected by telephone 3 to 10 days later.
**Conclusion**: The ability to collect dietary supplement use in the same format as food intake data will improve total nutrient intake estimation methods and permit researchers to examine associations based on nutrient sources, i.e., from foods versus dietary supplements.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# PROCESS USED TO DEVELOP THE 2010 DIETARY GUIDELINES FOR AMERICANS

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**Background:** The Dietary Guidelines for Americans (DGAs) are science-based dietary recommendations from the Federal government for promoting health and preventing chronic disease. They are updated every 5 years by law and are the basis of all Federal nutrition policies and programs.
**Objective:** The purpose of the current effort is to update the DGAs, using a scientifically rigorous process to evaluate recent scientific evidence.
**Description:** USDA established the Nutrition Evidence Library to conduct systematic reviews to inform nutrition policies and programs. USDA and HHS jointly appointed a 13-member Dietary Guidelines Advisory Committee, who reviewed the scientific literature to answer about 130 relevant questions. Another 20 questions were answered by data analyses conducted by Federal scientists. The Committee wrote concise conclusion statements and implications for each question. Two introductory chapters of their advisory report summarize and integrate their findings. Committee meetings were open to the public, and comments were received throughout the life of the Committee. Minutes, transcripts, and all information reviewed by the Committee is available at www.DietaryGuidelines.gov. After a public and agency comment period on the advisory report, Federal scientists will draft the 2010 DGA document; and independent Federal scientists will review it. After approval by the Secretaries of HHS and USDA, the 2010 DGAs will be released in December 2010.
**Conclusion:** The 2010 DGAs will present recommendations for promoting health and preventing chronic disease that were developed using an evidence-based process to ensure the quality, objectivity, utility, and integrity of the information on which the guidance is based.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

## USDA's *YOUR FOOD ENVIRONMENT ATLAS*

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**Background:** USDA's *Your Food Environment Atlas* is an online mapping tool developed by the Economic Research Service of the U.S. Department of Agriculture (USDA). It compares the food environment of U.S. counties – the mix of factors that together influence food choices, diet quality, and general fitness among residents.
**Objective:** The *Atlas* is designed to stimulate research and inform national, State, and local policymakers as they address the nexus between diet and public health.
**Description:** The *Atlas* contains 90 food environment indicators, most at the county level, allowing *Atlas* users to visualize and compare on a map how counties fare on each of the indicators.
**Conclusion:** USDA's *Your Food Environment Atlas* has been successful in making data accessible and understandable to a wide range of audiences. Since it was launched by the First Lady in February 2010 as part of her campaign against childhood obesity, the Atlas has had over 80,000 downloads.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# SPECTRAL FINGERPRINTING FOR IDENTIFICATION AND AUTHENTICATION OF FOODS AND BOTANICAL SUPPLEMENTS

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**Background:** The selection of foods (especially fruit, vegetables, processed foods, and supplements) available to the consumer is constantly changing. New cultivars, processing methods, recipes, additives, and exotic botanicals appear routinely. Characterizing them for nutrients and bioactive compounds, in a timely manner, is a difficult task. For botanical materials, adulteration is also a major concern. Spectral fingerprinting methods have been developed that allow rapid comparison of original, or authentic, products with new products.
**Objective:** To acquire spectral fingerprints, without chromatographic separation, for plant materials and use pattern recognition methods to discriminate between samples based on their chemical composition.
**Description:** Samples were ground and the powder analyzed by near-infrared spectroscopy. The powder was extracted with methanol-water and analyzed by UV and mass spectrometry without any prior separation. The spectral fingerprints were analyzed using analysis of variance and principal component analysis to differentiate between samples and to determine the variance associated with various growing parameters. Broccoli samples were differentiated based on variety, selenium treatment, and farming mode (organic vs. conventional). Dry beans were separately identified based on variety and growing site. Grapefruit were differentiated based on growing year, farming mode, and harvest. Ginseng were identified with respect to species (Asian, American, and notoginseng) and growing location (i.e. American ginseng grown in the US, Canada, and China).
**Conclusion:** Spectral fingerprinting is an extremely sensitive method for identifying differences in chemical composition. The biggest obstacle is establishing known, or authentic, materials on which to base the comparison.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# USDA STRATEGIES FOR MONITORING SODIUM CHANGES IN FOODS

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**Objective:** Concerns by the US public health community have led to the call for the reduction in sodium levels in packaged and processed foods. To monitor changes in key contributors of dietary sodium the Nutrient Data Lab (NDL), USDA has developed a plan to identify, rank, and monitor these foods.
**Materials and Methods:** NDL reviewed the sodium contents of 3,000 generic foods which provide the basis for the 7,000 foods reported in the What We Eat In America Survey (WWEIA). Of 3,000 foods, 2,000 agricultural commodities (e.g., fruits, meats) were deleted since they were not processed or packaged with the addition of salt or other sodium compounds. Sodium data for the remaining 1,000 foods and amounts consumed in the 2005-06 WWEIA cycle were used to rank the foods by sodium contribution. High ranking foods will be updated by chemical analysis. For other foods, label values for sodium will be compared to values found in the USDA's National Nutrient Database for Standard Reference. Where sodium has changed, new data will be generated, obtained from the food industry, or estimated by calculation.
**Results:** Approximately 60 generic foods contributed 50% of the sodium intake from all processed food categories. The list of 1000 key contributors of sodium is distributed across 23 food groups with the numbers of foods within the group ranging from <5 to 225.
**Significance:** Current data for sodium in foods will be needed to assess changes in sodium intake over time as levels of sodium in foods decline.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# ACCURACY OF WHOLE GRAIN COMPOSITION ESTIMATES DERIVED FROM FORMULATIONS CREATED FOR A SAMPLE OF WHOLE GRAIN CONTAINING COMMERCIAL FOOD PRODUCTS

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**Objectives**: Evaluate the accuracy of whole grain composition estimates (grams of whole grain) derived from food product formulations.
**Methods**: The University of Minnesota Nutrition Coordinating Center (NCC) maintains a food and nutrient database with the assistance of the NCC Food Calculation Program. Using this program NCC estimates nutrition composition values for brand name products by creating formulations (recipes) based on information provided in the ingredient statement and nutrition facts panel. To evaluate whether the formulations derived from this program will generate accurate whole grain composition values, 74 products in the marketplace were identified for which the grams of whole grain contained in the product was specified on the product packaging. Formulations for these products were created using the Food Calculation Program. Whole grain estimates from the formulations were then compared to product label values.
**Results:** Whole grain estimates derived from the formulations were +/- 3 grams of the labeled values for most products examined, however, accuracy varied somewhat by product category. For example, estimates from the formulations were within 3 grams of the labeled value for 21 of the 23 bread products examined (91%). For crackers, however, estimates from the formulations were within this margin for 23 of 30 products examined (80%).
**Significance:** Database developers must consider a formulation approach if they wish to add grams of whole grains to their database because most manufacturers do not provide this information for their products. Results suggest a formulation approach may yield estimates that are reasonably accurate for most whole grain containing products.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# CONTROLLED VOCABULARY FOR DESCRIBING DIETARY SUPPLEMENTS: LANGUAL PROPOSALS

Jayne Ireland[1]; Anders Møller[1]; Joanne Holden[2]; Heli Reinivuo[3]; Elly Buurma[4]; Benoit Labarbe[5]
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**Background**: Systematic food description is essential to the acquisition, processing, and dissemination of food composition data. LanguaL (http://www.langual.org) is a multilingual thesaurus using facetted classification, allowing each food to be described by a set of standard, controlled terms chosen from facets characteristic of nutritional or hygienic quality.
**Objective:** Recently, consumption of dietary supplements has become an important contributor of nutrient intake. The LanguaL thesaurus must therefore be expanded to allow standardized, systematic description of dietary supplements in food composition databases and in the future European Food Data standard CEN/TC_387.
**Description:** The LanguaL Technical Committee (TC) proposes to include a specific classification system for dietary supplements in LanguaL facet A (Product Type) and additional plants/chemicals in facets B and C (Source). It is proposed to update Facet H (Treatment Applied) using the European Commission Regulation (EC) No 1170/2009, amending Directive 2002/46/EC, which lists vitamins and minerals and substances that may be used in the manufacture of food supplements. Under facet E (Physical State), the TC proposes a specific classification according to supplement form (tablet, capsule…). Facet P requires more User Groups (women, seniors, children…). Finally, it is proposed to index distribution channels (retail, pharmacy…) in facet Z.
**Conclusion:** The LanguaL Technical Committee is seeking review and consensus concerning these proposals before adding the new descriptors to the thesaurus. A subset of products will then be tested, using the new descriptors. Finally, these LanguaL descriptors can be included in a modified Food Product Indexer program to assist systematic description of dietary supplements.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# DEVELOPMENT OF DATABASES TO MONITOR SODIUM IN PACKAGED AND RESTAURANT FOODS

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**Background:** The National Salt Reduction Initiative (NSRI) is working with food manufacturers and restaurants to voluntarily reduce sodium in their products, aiming to decrease U.S. population sodium intake by 20% over five years, which would result in tens of thousands of lives saved annually. The NSRI has developed 2012 and 2014 sodium targets for 61 packaged food and 25 restaurant categories. Two unique databases – one for packaged food and one for restaurants—were created to support this initiative.
**Objective:** The NSRI databases were designed to: (1) estimate baseline sodium content by category to inform target setting and (2) monitor changes in sodium content at 2012 and 2014.
**Description**: The NSRI Packaged Food Database combines sales and nutrition information to assess baseline sodium content and will be updated at target years. It includes sales data from Nielsen for 52 weeks ending in December 2008. The top 80% of sales in each category were matched by Universal Product Code to nutrition information from Guiding Stars Licensing Company. Incomplete nutrition information was supplemented by publicly-available sources. The database allows the calculation of sales-weighted average sodium by category and by company for baseline and target years. The NSRI Restaurant Food Database includes publicly-available nutrition data from the fifty largest quick-service restaurants adjusted with market share data from NPD Crest for each restaurant category.
**Conclusion**: The databases provide a mechanism for monitoring changes in salt content of the US food supply overall, by individual food category, and by company.

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*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# DETERMINATION OF FOOD VOLUME AND POROSITY USING IMAGING METHODS

Shivangi Kelkar; Scott Stella; Martin Okos
*Purdue University*

**Background**: Density is a physical characteristic which depends to a great extent on the experimental technique however requires accurate determination of volume and weight. However with porous foods such as grain food products, accurate determination of their true and apparent volume is challenging. Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and laser scanning are non-destructive techniques which were optimized to measure density of foods.
**Objective**: The objective of this study was to compare the density and porosity obtained from the CT, MRI and laser with other traditional techniques.
**Materials and Methods**: MicroCT 40 (Scano Medical Inc.) was used to determine the porosity of bread (classic white sliced, 25x25x12 mm). A 3D fast spin echo proton density-weighted pulse sequence (repetition time, TR = 1.5s; echo time, TE = 31.3ms; echo train length = 16; number of excitations, NEX = 4; frequency direction = superior/inferior; phase field-of-view = 0.75) was used to acquire 0.5mm isotropic resolution images of brownie using 3 Tesla General Electric Healthcare (Waukesha, WI) Signa HDx magnetic resonance imager. Laser scanner was setup to obtain 3-D volume of selected porous foods.
**Results**: The threshold of images was set using Ostu's algorithm and quantified using matlab software to calculate porosity. Food volume was calculated from the images from laser scanner. The results obtained were compared with those from the gas pycnometer and seed displacement techniques.
**Significance:** CT, MRI and laser scanner have great potential to accurately estimate density of porous foods.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# TRACKING FOODS FROM PRAIRIE TO PLATE

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Assessing food intakes is as central to dietary studies as assessing nutrient intakes. Just as we need nutrient databases to translate foods consumed into the amounts of nutrients they contain, we need tailored databases to translate those same foods—which may be composite foods or mixtures—into their ingredients and account for all those ingredients in nutritionally-relevant groupings. Nonetheless, although nutrient databases are widely available, there are scant resources for measuring specific food and food group intakes and those that are available have not received adequate support.

Assessing intakes of nutritionally-relevant food groups is key to dietary studies across the socio-ecological spectrum. At the individual level, such assessments have been used in population monitoring, examining the relationship between diet and health, and evaluating the effects of interventions. However, the need to measure the community- and macro-level food environments as well is becoming increasingly apparent in the context of an obesity epidemic and alarming rates of other diet-related chronic disease. This presentation will demonstrate what can be learned from using appropriate databases to track foods “from prairie to plate,” using the Healthy Eating Index 2005 (HEI-2005) as a common metric across levels. It will also describe the database gaps in our surveillance system and what might be done to fill them.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# VARIABILITY OF OMEGA-3 FATTY ACIDS (Ω-3 FAs) IN NUTRIENT DATABASES AND RELATED RESEARCH

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Dietary guidance recommends consumption of Ω-3 FAs for their many health benefits. Specific recommendations have been made for fish, one important source of marine-derived Ω-3 FAs. Increasingly, there are fortified foods in the marketplace that are sources of Ω-3 FAs, both marine-derived (eicosapentaenoic acid; EPA, docosahexaenoic acid; DHA) and plant-based (α-linolenic acid; ALA). Available nutrient databases contain information about amounts of these fatty acids in foods, however, it is not comprehensive, and, importantly, quite variable. Reasons for limited data include: a changing marketplace of Ω-3 FA foods; and limited resources to comprehensively update nutrient databases. Even within a species of fish, there is considerable variation in Ω-3 FA levels that reflects differences in region, season, age of fish, as well as aquaculture practices implemented for "farm-raised" species. Eggs high in Ω-3 FAs (fortified?) are another food that is highly variable, a result of the differing diets fed to laying hens. New fats and oils from genetically enhanced crops that emphasize one or more Ω-3 FAs also are emerging in the marketplace; the nutrient composition of which is markedly different from the "parent" fat/oil. Consequently, the addition of such products, in combination with the limitations and variations in current nutrient databases, make it challenging to accurately assess Ω-3 FA intake. Moreover, large discrepancies in diet assessment methodologies make it challenging to collect accurate intake data. Since fish consumption is highly variable, 24-hr dietary recall data can result in an invalid assessment of marine-derived Ω-3 FAs intake.

We developed a dietary tool to assess long chain Ω-3 FA intake that was validated using the Ω-3 Index (OMX), a biomarker of Ω-3 FA intake. A single-question tool accurately captured the frequency of Ω-3 FA-rich fish consumption compared with dietary recall data. The question was: "How often do you eat—as a main course—tuna or other non-fried fish? a) > 1x/month, b) 2-3x/month, c) 1x/week d) 2x/week, e) >2x/week." Utilizing the food frequency questionnaire data as ordinal categories, the single question was able to explain 42% ($p<0.01$) of the OMX variance, while the continuous values for n-3 intake from the recall data explained 15% ($p=0.04$). Finally, the food sources of n-3 specified in the question accounted for at least 70% of the n-3 intake in the non-supplementing population.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# RETAIL DISPLAY CONDITIONS OF CONTINUOUS LIGHT AND DARK ON THE DISPOSITION OF VITAMINS IN BABY-LEAF SPINACH

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Human-health benefits from the consumption of fruits and vegetables are due to their many bioactive compounds. These compounds are heavily influenced by genetics (i.e. cultivar) and the environment, especially the many pigments and vitamins that can degrade during processing and storage. Marketing conditions today allow for produce to receive 24-hours of light per day during its retail display. Plant derived essential human-health vitamins (ascorbic acid- vit. C, folate – vit. B9, phylloquinone-vit. K1, and carotenoids lutein and β-carotene-provit. A) are required for photosynthesis and are activated by light conditions even under refrigerated storage. Spinach leaves, notably abundant in the aforementioned human-health vitamins, were harvested at peak plant maturity from flat-leaf and crinkled-leaves cultivars as baby-leaf and larger leaves; then placed in commercial, clear-polymer retail boxes and stored at 4oC for up to 9 day under continuous light or dark. Baby-leaf spinach stored under continuous light had significant higher levels of vitamins and carotenoid compounds, but were prone to wilting especially the flat-leaf cultivar. Findings from this study revealed that spinach leaves exposed to continuous light during storage were, overall more nutritionally dense than leaves exposed to continuous dark.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# THE EUROFIR eSEARCH - THE EUROPEAN FOOD COMPOSITION DATABANK SYSTEM

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**Background**: The EuroFIR (European Food Information Resource Network) project is building a comprehensive food composition databank (FCDB) platform.
Objective: In Europe, 21 national and private FCDBs are presently Internet-based. Their presentations cover a wide range of technical solutions and layouts. In order to standardize food composition work in Europe, a common standard is necessary. This requires national and specialized FCDBs to be established according to common principles, with data and metadata presented in a uniform way.
**Description:** The EuroFIR FCDB platform, eSearch, has been developed according to EuroFIR recommendations for food composition data and state-of-the-art web building and information technology. Description of foods and compositional values uses standard vocabularies (LanguaL and EuroFIR thesauri on components, methods, etc.). A well-defined XML data transport mechanism facilitates uniform data interchange. EuroFIR eSearch includes more than 30 national and specialized datasets, and intensive work on value documentation has been done. The EuroFIR recommendations will form the basis for a European Standard to be adopted within the CEN framework (TC 387). For data interchange, an XML template (EuroFIR Food Data Transport Package) has been developed and implemented as a web service. Tests have shown good results. Further web services are under development.
**Conclusion**: For the user, the EuroFIR approach provides standardized presentation of validated data. The EuroFIR project demonstrates the benefits of using standardized systems for linking and describing food composition data.

**Funding:** The EuroFIR Network of Excellence (FOOD-CT-2005-513944) is funded under the EU 6th Framework Food Quality and Safety Program.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# NEW RELEASE OF USDA FOOD AND NUTRIENT DATABASE FOR DIETARY STUDIES

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*USDA-ARS-BHNRC-Food Surveys Research Group*

**Background:** The Food and Nutrient Database for Dietary Studies (FNDDS) is developed by USDA's Food Surveys Research Group to collect, code and analyze dietary intakes from the What We Eat In America, National Health and Nutrition Examination Survey (WWEIA, NHANES).
**Objective:** A new version of FNDDS containing updated food descriptions, weights for common portions, and nutrients is prepared for each two-year survey. To keep FNDDS current, information reported by survey respondents is monitored for new foods and portion sizes. Also, comprehensive reviews of database entries (foods, weights, and recipes) are conducted on a regular schedule.
**Description:** FNDDS 4.0 includes nearly 300 food items added for new foods reported in 2007-2008. Approximately 30 food items were discontinued for products no longer available. Food descriptions were revised for manufacturer name changes. Approximately 3,000 revisions were made to weight data including new package sizes and changes in fast food portion sizes. Values for vitamin D (D2+D3) were added for all foods, bringing the total number of nutrients to 65. Linkages to the USDA National Nutrient Database for Standard Reference (SR) were revised, including changes to account for variations in vitamin D fortification of milk and margarine used in commercial vs. home-made foods. Updated nutrient values from SR22 were incorporated.
**Conclusion:** FNDDS 4.0 contains approximately 7,000 foods and 30,000 weights. It was used to estimate nutrient intakes for WWEIA, NHANES 2007-2008. By mid-2010 it will be available on-line via the What's In The Foods You Eat Search Tool, and for download from http://www.ars.usda.gov/ba/bhnrc/fsrg.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# FOOD CHANGES FOR HEALTH IMPACT: THE FRONTIER IN UPDATING FOOD AND NUTRIENT DATABASES

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**Background:** One of the frontiers identified by the National Nutrition Database Conference Planning Committee is accounting for nutrient variations of foods in dietary databases. Changes in the food supply and marketplace have always been a challenge for keeping databases up-to date. Food science and technology advancement are resulting in an explosion of food products that are different in characteristics important in database development, namely components and nutrients that impact health. In fact, food product changes today and in the future will be driven more and more by the public's desire for products with enhanced health benefits.
**Objective:** To address the challenges in updating databases to accurately capture the marketplace given the fortification and enhancements of foods.
**Description:** Major changes in the food supply that are impacting food and nutrient databases will be presented. Strategies employed to assure that What We Eat in America, NHANES dietary data reflect the food marketplace will be highlighted as an example.
**Conclusion:** The frontier of food changes for health impact will challenge our knowledge and skills to keep databases accurate and reflective of the food marketplace.

*Funding source: USDA*

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# THE USE OF SELF-REPORTED FOOD INTAKES TO FORMULATE HYPOTHESES FOR EXPECTED AND UNEXPECTED FINDINGS IN COPPER, ZINC, AND MAGNESIUM SUPPLEMENTATION STUDIES

Forrest H. Nielsen[1]; Angela J. Scheett[2]; LuAnn K. Johnson[2]; Henry C. Lukaski[1] (retired); Zamzam K. Roughead[3]
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**Objective:** Determine whether food diary data provide possible explanations for results from supplementation studies that show limited relationships to blood and/or bone indicators of status.
**Materials and Methods:** One two-year study assessed the daily supplementation with 600 mg calcium or 600 mg calcium plus 2 mg copper and 12 mg zinc on bone loss in 164 postmenopausal women. Five-day food diaries were completed four times during the study. Another study assessed inflammatory status by measuring C-reactive protein (CRP) in 100 women and men, ages 51-85, with sleep disorders and supplemented with 300 mg magnesium or a placebo for eight weeks. A 3-day food diary was completed three times.
**Results:** Bone loss indicated by decreased whole body bone mineral densities and T scores was significant in women supplemented with copper and zinc, but not with calcium alone. Food diary data suggested possible reasons for not finding the expected attenuation by copper and zinc. Adequate copper status (only four women consumed <237 mg magnesium/day (95 percentile of a suggested EAR). Magnesium deficiency may induce bone loss and magnesium balance has been shown to be decreased by zinc. An expected decrease in plasma CRP with magnesium supplementation was associated with dietary magnesium in the other experiment.
**Significance**: Food diaries provide useful information in supplementation studies.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# REVIEW OF MEASURING AND PREDICTING DENSITY OF FOODS

Martin Okos
*Purdue University*

Accurate measurement of dietary intake has always been a concern for researchers. Since it is difficult for most individuals to accurately identify the proper quantity of food consumed, the application of image based technology using mobile phones has been shown to be helpful for dietary assessment. Although images basically capture volumetric data, the capacity and precision of these methods to estimate energy and nutrients depends upon the accurate estimation of the weight of the food. The link between and the accurate estimation of the weight of the food from volumetric data is density. Although the Food and Nutrient Database for Dietary Studies (FNDDS) is being adopted to provide the necessary data, a significant portion of data base provides incorrect or missing volumetric/density data. Even if density data is available, a large variability exists in food density within any group of food depending on ingredients and processing methods. Not only do the structural properties of food but also the density measurement techniques play an important role in density values. A review of the various methods to determine density will be given. Novel density measurement techniques and prediction methods will be discussed. A density estimation methodology to reduce the burden of measurements will be suggested in an effort towards building an accurate dietary assessment tool.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# MAINTENANCE OF NUTRITION DATA FOR AGRICULTURALLY-BASED INGREDIENTS: AN INDUSTRY PERSPECTIVE

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**Objective:** General Mills produces a wide variety of grain-based products including cereal, soups, grain snacks, refrigerated and frozen dough, meal and baking products. The ingredient database required to support detailed nutrient calculations for this product portfolio is large and varied with approximately 5,000 ingredients. Although ingredient vendors provide nutrient information for their ingredients, there are specific agriculturally-based food ingredients which General Mills analyzes to assign nutrient values. A three year analytical study was commissioned to document the nutrient content of flour ingredients.
**Methods:** The study design included sampling wheat grown in the Eastern and Western United States for 2008 and 2009 crop years. Multiple samples were collected and analyzed for 29 nutrients.
**Results:** The initial results of the study indicated differences in moisture, protein, fiber and micronutrient composition for whole wheat flour. Growing location and variety influenced nutrient values more than crop year. Further research is planned for subsequent crop years.
**Significance:** The challenges associated with maintaining the nutrient database for agriculturally-based ingredients include variability due to: crop year; variety and growing location. These factors can result in varying nutrient values for key nutrients and impact labeling decisions and claim substantiation for products produced in multiple locations for national distribution. Further, finished product formulas may need to vary in order to maintain consistent product quality for those same nationally distributed products. Whole wheat flour is a key agriculturally-based ingredient used in many General Mills products.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# SAMPLING PLANS FOR MULTIVITAMINS AND DIETARY SUPPLEMENTS CONTAINING OMEGA-3 ACIDS IN THE DIETARY SUPPLEMENT INGREDIENT DATABASE (DSID)

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**Background:** The Nutrient Data Laboratory (NDL), Beltsville Human Nutrition Research Center, USDA, and the Office of Dietary Supplements (ODS) at NIH, are collaborating to develop and maintain the Dietary Supplement Ingredient Database (DSID), an analytically validated database of representative ingredient values for dietary supplements. The DSID-1, publicly released in 2009, provides ingredient estimates for adult multivitamin/minerals (MVMs). Studies of other dietary supplements are underway.
**Objective:** Methods used to develop statistical sampling plans for MVM and omega 3 studies will be compared.
**Description:** Each DSID study is designed using a statistical sampling frame to develop product-specific plans for collecting dietary supplement samples, to assure that samples being analyzed are representative of the population of all products of the specific type. Sampling units are obtained from multiple U.S. geographic areas to obtain reliable and representative estimates of means with known variability for ingredient content. Resources used to develop sampling plans include NHANES dietary supplement data which are population-weighted to indicate usage trends, nationwide shopping surveys, dietary supplement researchers, cooperating statisticians, and market share information for the supplement industry. Examples of sampling plans will be presented.
**Conclusion:** Products analyzed for DSID are purchased using statistically based sampling plans. Analytically-based estimates in DSID releases can be combined with food intake data to assist researchers in making better quantitative estimates of total dietary intake for evaluating the nutritional status of Americans.

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34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# EVALUATION OF FNDDS FOOD ITEMS FOR SELECTION IN CONTROLLED FEEDING STUDIES

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**Background:** FNDDS is commonly used in controlled feeding studies to estimate the energy and nutrient content of foods served and consumed. When biological markers of nutrient intake are also collected in these studies, proximate analyses of food items can be used to account for any discrepancies between the nutrient data and the biomarker.
**Objective:** The objective was to determine if the energy content, measured using a bomb calorimeter, of foods selected to represent foods in FNDDS would match the published energy values in FNDDS.
**Materials and Methods:** Adolescents between 11-18 yr were recruited to eat all meals and snacks in a controlled feeding environment over a 24-hour period (12 boys, 3 girls). Each food item served in this study matched a FNDDS code. Using duplicate meals and snacks, samples of the 20 foods were weighed, homogenized, freeze dried, and analyzed in triplicate using a Parr® 1281 Oxygen Bomb Calorimeter.
**Results:** Eleven of the twenty food items had energy values in FNDDS that were within ±10% of the measured energy. Seven were within ±15% and only 2 food items deviated beyond these ranges. One of these food items was a combination food, e.g., spaghetti with sauce and cheese, which is challenging to replicate to FNDDS and more difficult to make a homogeneous sample.
**Significance:** These results indicate that selecting foods from FNDDS for controlled feeding studies will provide accurate data.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# DEVELOPMENT OF DENSITY PREDICTION METHODOLOGY

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**Background & Objective:** Porosity of foods is an important tool for nutritional and dietary studies, and its prediction is necessary to accommodate new or immeasurable food items. Choi and Okos have used large amounts of data to derive empirical relations of other food parameter such as true density and thermal conductivity. The Food and Nutrient Database for Dietary Studies (FNDDS) from the United States Department of Agriculture (USDA) provided the necessary bulk or apparent volumetric data as well as corresponding composition data required to correlate composition to porosity prediction.
**Materials & Methods:** Using simple multivariate linear regression techniques combined with neural networks, model parameters were found such that it is possible to determine apparent density from porosity and void fraction prediction based on food composition, measurement type (bulk, porous, or both), processing conditions, and true density calculations. Additionally genetic algorithms were used to extract detailed information from nutrient labels concerning the quantity of the ingredients listed. This information was used as an input for the density prediction models.
**Conclusions:** The results indicate that the apparent and bulk density problem is solvable, but may require substantial additions to food databases. Information regarding food processing conditions such as time, temperature, and cooking method play a large role in the volume of the final product and hence the density.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# DISAGGREGATION OF COMPOSITE DISHES IN THE U.K. NATIONAL DIET AND NUTRITION SURVEY FOOD COMPOSITION DATABANK AND IMPACT ON MEAT AND FRUIT AND VEGETABLE INTAKES

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*[1]MRC Human Nutrition Research; [2]National Centre for Social Research; [3]Food Standards Agency*

**Objective:** In past National Diet and Nutrition Surveys (NDNS) in the UK, fruit and vegetable intakes have been described as discrete portions, and have not included those within composite dishes. Meat and fish intakes have been reported in subdivision by type, but mixed meat dishes have been assigned intact into these subdivisions. In order to determine accurate and complete intakes of meat, fish, fruit and vegetables, we have undertaken the disaggregation of all composite food codes in the NDNS food composition databank and used these data to describe intakes from the first year of the new NDNS rolling programme1.
**Materials and Methods:** Of 4821 existing food codes on the databank, 3030 contained the disaggregation components of interest, and were disaggregated using information on recipes, manufacturer data, haem iron, vitamin A and fructose contents of composite dishes. New composite dishes were disaggregated prospectively.
**Results:** Taking vegetables from composite dishes into account, vegetable intakes were 25-35g per day higher than using previous methods for children and 40-50g per day higher for adults, while fruit intakes were only 2-6 g per day higher than with previous methods. The intakes resulted in averages of 4.4 portions per day for adult men and women compared with the “5-a-day” recommendation. Meat intakes were some 40% lower when non-meat components of meat dishes were excluded.
**Significance:** These results indicate substantial differences from traditional approaches and emphasize the need for nutrient data to be presented at the ingredient level in food composition tables. 1 http://www.food.gov.uk/multimedia/pdfs/publication/ndns0809

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# MEASURING DENSITY USING SEED DISPLACEMENT

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**Background:** Food volume for liquids such as beverages and powders such as flour are measured using standard teaspoons, tablespoons, cups, and quarts. This provides a volume measure to compare to weight to determine density. Foods such as whole vegetables, fruits, nuts and meats that can be diced, chopped, slivered or pureed can be measured in standard volume measuring tools, but potential error is compounded with larger pieces because the mass cannot conform to the shape of the vessel. As air spaces enlarge, density falls, until volume measures cannot be used to determine density. An alternate method using seed displacement allows for a very accurate estimation of volume, and therefore density, for irregularly shaped foods. However, many foods have significant amounts of air incorporated within their structure that contributes to measurement error.
**Objective:** Because use of photography to measure food intake requires a known density, we have measured selected foods from the USDA Food and Nutrient Database for Dietary Studies (FNDDS) that do not have a reported weight to volume ratio. Our goal is to derive a density measure for all foods on the FNDDS database, either using data provided on the database, or determining density for representative foods.
**Description:** We also developed default density values for use when measured density is not available. Our default values vary from 0.4 for an ice cream cone to approximately 1.3 for pancake syrup.
**Conclusion:** Assigning new foods to default categories requires knowledge about the physical characteristics of the food including ingredients and aeration.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# THE CHALLENGES OF INCORPORATING CHROMIUM INTO A FOOD AND NUTRIENT DATABASE

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**Background:** Interest in chromium sparked in the early 1960's when Mertz and Schwarz first demonstrated that trivalent chromium (Cr3+) plays an important role in glucose metabolism. Since then, Cr3+ has become recognized as an essential trace element, and research has focused on its potential metabolic and cardiovascular benefits.
**Objective:** A thorough review of the literature was conducted to examine the extent to which valid and reliable data is available on the chromium composition of foods.
**Description:** Through the literature review, a number of key issues were identified and need to be considered when contemplating adding chromium to a food and nutrient database. Foremost, chromium composition information reported in the literature prior to 1980 should not be relied on because a problematic analytical apparatus was generally used until that time. Next, paucity of data emerges as another challenging issue and can affect database completeness. Finally, large variation in reported chromium contents of overall and unique food may render disputable representative chromium values. This variation has been speculated to originate from differences in the chromium content of the soil in which the food was grown as well as plant cultivar and animal breed. Leaching of chromium from stainless steel preparation equipment and/or cookware is also hypothesized to contribute to the variation observed in reported values.
**Conclusion:** Database developers must carefully consider the validity and reliability of available information on the chromium composition of foods when deciding whether to incorporate chromium into or exclude it from a nutrient database.

34th National Nutrient Databank Conference
*Prairie to Plate: Exploring Food and Nutrient Database Frontiers*
**12-14 July 2010, Grand Forks, North Dakota**

# ADAPTING THE US DEPARTMENT OF AGRICULTURE'S AUTOMATED MULTIPLE PASS METHOD FOR USE WITH A NATIVE AMERICAN POPULATION

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*[1]Westat; [2]Environment International*

**Background:** The Upper Columbia River Tribal Use and Consumption Survey is being conducted by the US Environmental Protection Agency (EPA) and the Colville Confederated Tribes (CCT) to quantify exposures to local resources (i.e., foods, herbs, medicines, materials used in clothing, ornaments, and infrastructure). To assess usual food intake, four 24-hour dietary recalls will be conducted and coded using USDA's Automated Multiple Pass Method (AMPM) and SurveyNet systems.
**Objective:** To customize the AMPM and 24-hour dietary recall data collection procedures for administration in a Native American population; link indigenous foods reported to SurveyNet to allow for nutrient analysis.
**Description:** In collaboration with Environment International (EI), Westat developed a list of indigenous foods likely to be consumed by the CCT members in all four seasons. The AMPM Main Food List was expanded to include these indigenous foods; in some instances multiple entries were used to capture a food with multiple food names. In addition, data collection procedures were developed to capture details on indigenous foods not included in the AMPM food probes. For example, procedures were developed to record indigenous foods used as ingredients in recipes and to identify where a food was locally grown or caught. Westat researched the nutrient content of indigenous foods and identified suitable matches to be applied during the SurveyNet coding process.
**Conclusion:** The AMPM database and data collection procedures can be customized to capture indigenous foods consumed by CCT members, and the FNDDS food codes can be applied to allow for nutrient analysis of those foods.