The National Food And Nutrient Analysis Program: Accomplishments and Lessons Learned

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Abstract

The National Food and Nutrient Analysis Program was developed by USDA in cooperation with the National Heart Lung and Blood Institute and 17 other institutes and offices at NIH to improve the quality and quantity of data in USDA's nutrient databases. Over 850 foods have been analyzed for up to 150 different food components. As a result, data for trans fatty acids, sugars, carotenoids, vitamin K, and tocopherols have been added to the database. Nutrient values for many food groups (e.g., ground beef, fruits, vegetables, pizza, fast foods and other mixed dishes) were updated and expanded. Special interest databases on flavonoids, proanthocyanidins, ORAC, choline, and fluoride were released. USDA developed procedures to collect nationwide samples using statistically valid sampling plans, process samples at a central location using established protocols, analyze them at qualified, analytical laboratories, and review results for data quality. Important lessons learned include: 1) most commercial labs can perform routine proximate analyses with good precision and accuracy; 2) for other analyses, results from some laboratories are clearly superior; 3) it is difficult to get research grade data from commercial laboratories; 4) laboratories using AOAC methods may not follow the methods precisely; and 5) a rigorous quality control program is essential.

Background

The National Food and Nutrient Analysis Program (NFNAP) was instituted in 1997 through an interagency agreement between USDA and 17 offices and institutes of the National Heart Lung and Blood Institute of the NIH. This represented a major increase in scope of USDA's food composition work and the development of a systematic process. It is the sole source of funding for the analyses of food components at NDL. To date, we have analyzed over 1000 diverse food items, covering a wide variety of foods (Table 1). These include USDA commodities, used in a variety of programs and industrial ingredients which allow NDL staff to make better estimates of formulations used to impute values for a variety of formulated foods.

As part of this effort, we have built an infrastructure to cover all aspects of the project (Figure 1), which includes:

- A nationally representative, proportional to population sampling plan based on US Census data, developed in collaboration with the National Agricultural Statistics Service. This sampling plan, with minor variations, was used to sample food items from supermarkets and fast food restaurants on a nationwide basis. Specialized sampling plans were also developed, e.g., for the fluoride database and the American Indian/Alaskan Native (AIAN) database
- A cooperative agreement with the Food Analysis Laboratory Control Center (FALCC) at VPI&SU provides for sample preparation and quality control.
- Contracts are made with commercial analytical labs for general analysis (proximates, minerals, vitamins, fatty acids, amino acids) of the samples
- Cooperative agreements with university and government scientists for analysis of the samples, for those components where specialized expertise is needed:
  - Vitamin K – Tufts University
  - Fatty acids – University of Maryland
  - Proanthocyanidins, ORAC – University of Arkansas
  - Carotenoids and Flavonoids – Food Composition Lab, USDA-ARS
  - Fluoride – University of Iowa
  - Choline – University of North Carolina

Table 1. Foods items analyzed by food groups

Dairy and eggs
Cheese – 19
Milk & butter – 5
Eggs – 2

Spices and herbs - 23

Baby Foods - 14

Fats and Oils
Shortenings and Oils – 16
Margarine and spreads - 10
Dressings and mayonnaise – 12

Poultry products
Chicken – 28
Turkey - 2
Organ meats – 2

Soups, Sauces, and Gravies
Soups - 11
Sauces - 3
Gravies - 2

Sausages and Luncheon Meats
Hot dogs and Sausages – 12
Luncheon meats – 2

Breakfast Cereals
Ready-to-eat – 18
Cook and serve – 17

Fruits and Fruit Juices
Fruit - 56
Juices - 7

Pork products – 12

Vegetables and vegetable products
Leaves - 15
Roots – 15
Potatoes – 15
Other – 42

Nuts and seeds - 13

Beef products - 21

Beverages
Alcoholic - 4
Carbonated - 8
Other – 63

Finfish and Shellfish Products
Finfish & products - 10
Shellfish – 2

Legumes and legume products
Beans and peanuts - 17
Soy products - 14

Baked Products
Bread, rolls, bagels and tortillas – 18
Cookies and crackers – 8
Pancakes and waffles – 9
Cakes, muffins and donuts – 11
Pies & Pastries – 18
Other – 6

Sweets
Sweeteners and frostings- 9
Candies – 8
Desserts – 13

Cereal Grains and Pasta
Grains – 28
Pasta – 7

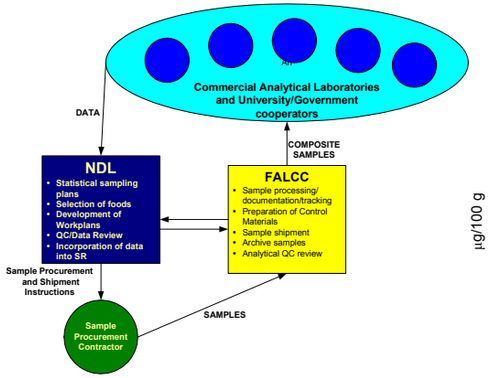
Fast Foods
Sandwich and entrees - 37
Breakfast - 16
Pizza – 24
Sides - 5
Beverages - 16

Meals, Entrees, and Sidedishes - 47

Snacks - 15

American Indian and Alaskan Native
Alaskan Native Foods – 54
Apache – 6
Navajo –20
Shoshone-Bannock – 10

Figure 1. NFNAP Infrastructure



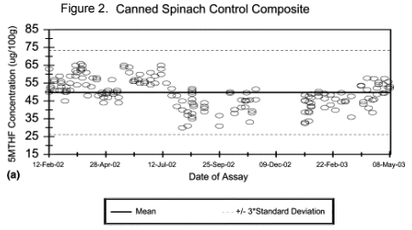
Results

Folate stability and variability

The stability of folate in a number of foods was evaluated as part of a project to validate the procedures used to composite samples at a central location and ship them to other analytical labs. This research showed that folate would be stable for the periods of time needed to prepare and ship the samples to various labs for analysis (Figure 2)

However, labs varied in their ability to produce reliable, consistent folate values. Results from several labs using different methods for analyzing folate in foods were evaluated and the results reported (Figure 3).

Figure 2. Canned Spinach Control Composite



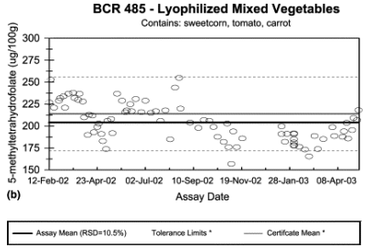
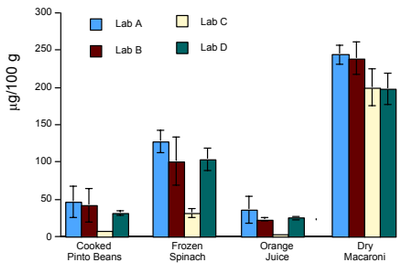


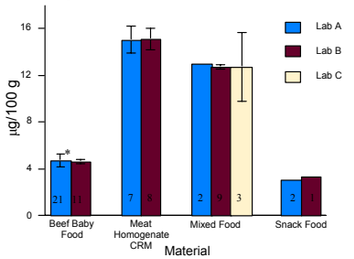
Figure 3. Folate variability between labs for different food items.



Lab Performance for various QC Materials

When analyzing selenium, the labs showed good agreement and reliability with a variety of CRMs (Figure 4) for two different methods: Hydride generation (Labs A & C) and isotope dilution GC/MS (Lab B). Similar agreement was seen with results for fatty acids, cholesterol and phytosterols in a control composite developed for NFNAP (Figure 5). Analysis of CRMs and control composites is part of the quality control program developed as part of the NFNAP.

Figure 4. Selenium in Various QC Materials



*Error bars are SD, Numbers in bars are n

Figure 5. Comparison of Analytical Results for Candy Control Composite

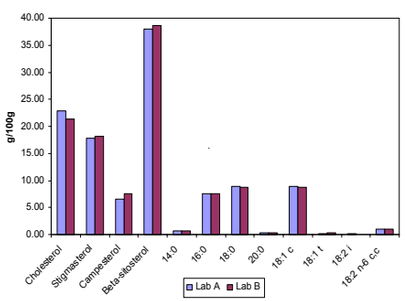
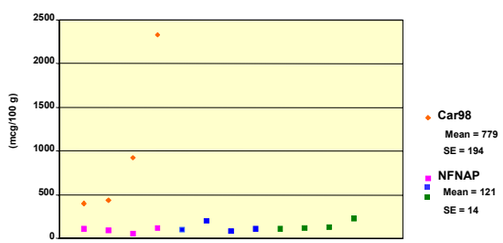


Figure 6. β-Carotene in Broccoli



Database updates

With newly generated data from NFNAP, NDL was able to update and expand the data in the USDA National Nutrient Database for Standard Reference. The following components have been added to the database:

- Individual carotenoids
- Individual sugars
- Vitamin K

We are also able to respond to changes in reporting various nutrients as called for in various reports by the National Academy of Sciences, Institute of Medicine:

- Adding Dietary Folate Equivalents (DFE)
- α-tocopherol replacing α-tocopherol equivalents (ATE)
- Retinol Activity Equivalents (RAE) replacing Retinol Equivalents (RE)

A number of special purpose databases were developed as part of NFNAP. These have been released on NDL's web site:

- Flavonoids
- Proanthocyanidins
- Choline
- Fluoride

Specific nutrient changes in the database

Margarine and spreads - Market research by NDL staff prior to initiating the analytical program indicated that the range of products in the marketplace offered values for total fat between 0 and 80% with the most prevalent products now providing 53% fat. Trans fatty acid values in margarines and spreads ranged from 4.4 g/100 g in 48% fat spreads to 19.7g/100 g in regular (80% fat) margarine. Fat free products, contained 0.04 to 2.45 g per 100g, which on a per serving basis, would allow a *trans*-fat free label declaration.

Fresh Fruits and vegetables - These data showed that the individual carotenoid content of broccoli is now lower than previously reported (Figure 6). The vitamin C content of the MDII variety of pineapple is twice the amount in the older cultivars. MDII pineapple is frequently the only type of fresh pineapple now found in retail markets. This part of the study was inititiated to generate phytonutrient data on 59 fruits, nuts and vegetables.

Ground beef - A ground beef study was conducted to reflect the broader range of ground beef products available in the retail market. Previously, data in SR was limited to products containing 17%, 23%, and 27% fat, which were described as extra lean, lean, and regular, respectively. In today's market, ground beef products containing 7% and 10% are quite common. The new study provides nutrient information for ground products (both raw and cooked) ranging in fat content from 5% – 30%.

An analysis of fat in fast food pizzas showed a higher fat value of 9.84 ± 1.77 in cheese pizza .vs. a value of 5.10 in SR16.1.

The fat level of frozen French fried potatoes varies among the different types–shoestring, 6.76 g/100g; crinkle-cut, 5.13 g/100g; and steak-cut, 3.76 g/100g.

Conclusion

NDL has built an extensive infrastructure to support NFNAP including sample design, food sampling, sample handling and preparation procedures, quality control, and validated analytical procedures.

As a result, NDL has generated data for over 1000 food items, resulting in a substantial update and expansion of USDA food composition databases.

These data are essential to food and nutrition research, public policy and trade.

This work was supported by USDA, ARS and NIH agreement # Y1-HV-8116.