# Assessing Vitamin D Content in US Foods and Supplements

## Development of the National Nutrient Database

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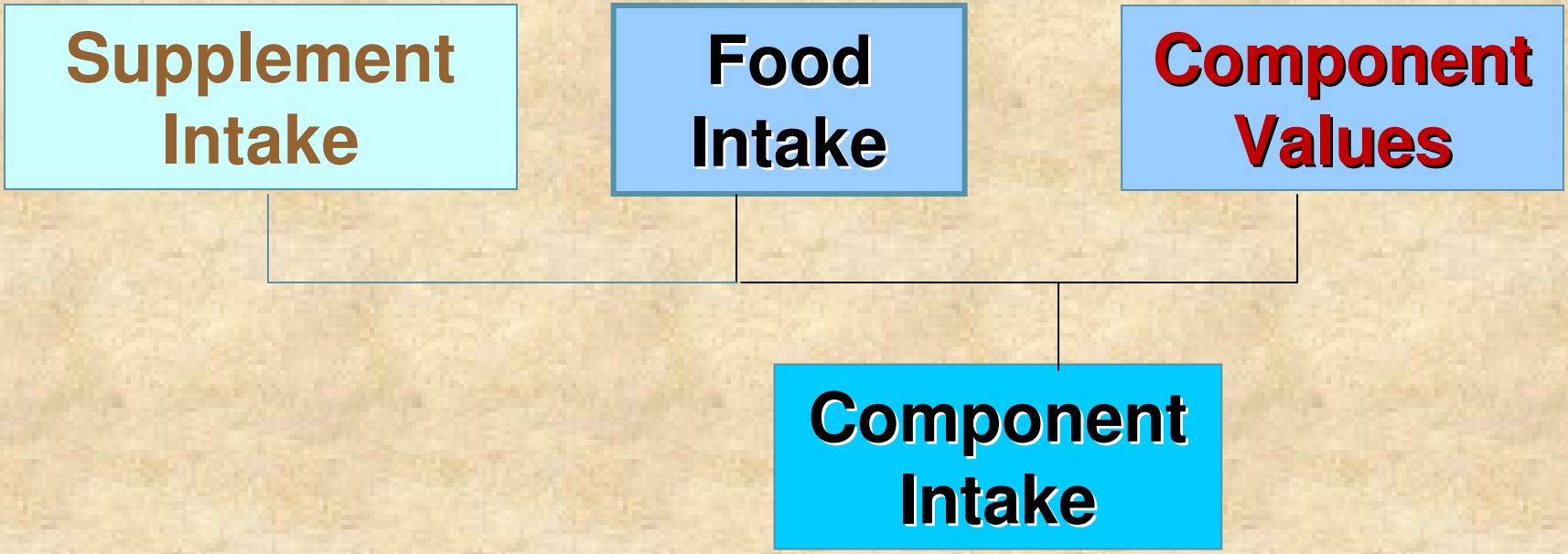
***A knowledge of the chemical composition of foods is the first essential in dietary treatment of disease or in any quantitative study of human nutrition.***

***-McCance & Widdowson, 1940 United Kingdom***

# Intake Assessment of Dietary Components



# Components in Foods/DS May:

- Occur naturally (physiological function)
- Be added to foods (fortification)
- Be the result of recipes or formulations (e.g. manufacturing) (DS)
- Be generated in response to biological stress (e.g., UV exposure)
- Be contaminants (direct or indirect) (DS)
- May accumulate due to feed or fertilization

# Today's Objectives:

- To introduce you to USDA's National Nutrient Databank
- To present the vitamin D project
- To discuss database development

# What is the USDA National Nutrient Databank?

- The U.S. "reference" source for food composition data
- National Nutrient Database for Standard Reference (SR22) provides the foundation for most other applications:
  - National surveys: NHANES: What We Eat in America
  - Therapeutic, clinical, and research databases
  - Product development, labeling, regulation
- Basis of federal, state, local food policy
- Used by consumers and students
- Availability – **www.ars.usda.gov/nutrientdata**

# USDA's Nutrient Database for Standard Reference (SR22)

- Contains data for 7500 foods
- Agricultural commodities, formulated foods
- Generic estimates for agricultural commodities, processed, and prepared fruits, vegetables, meats, poultry, grains
- Brandname and generic estimates for RTE cereals, selected fast foods, candies, beverages

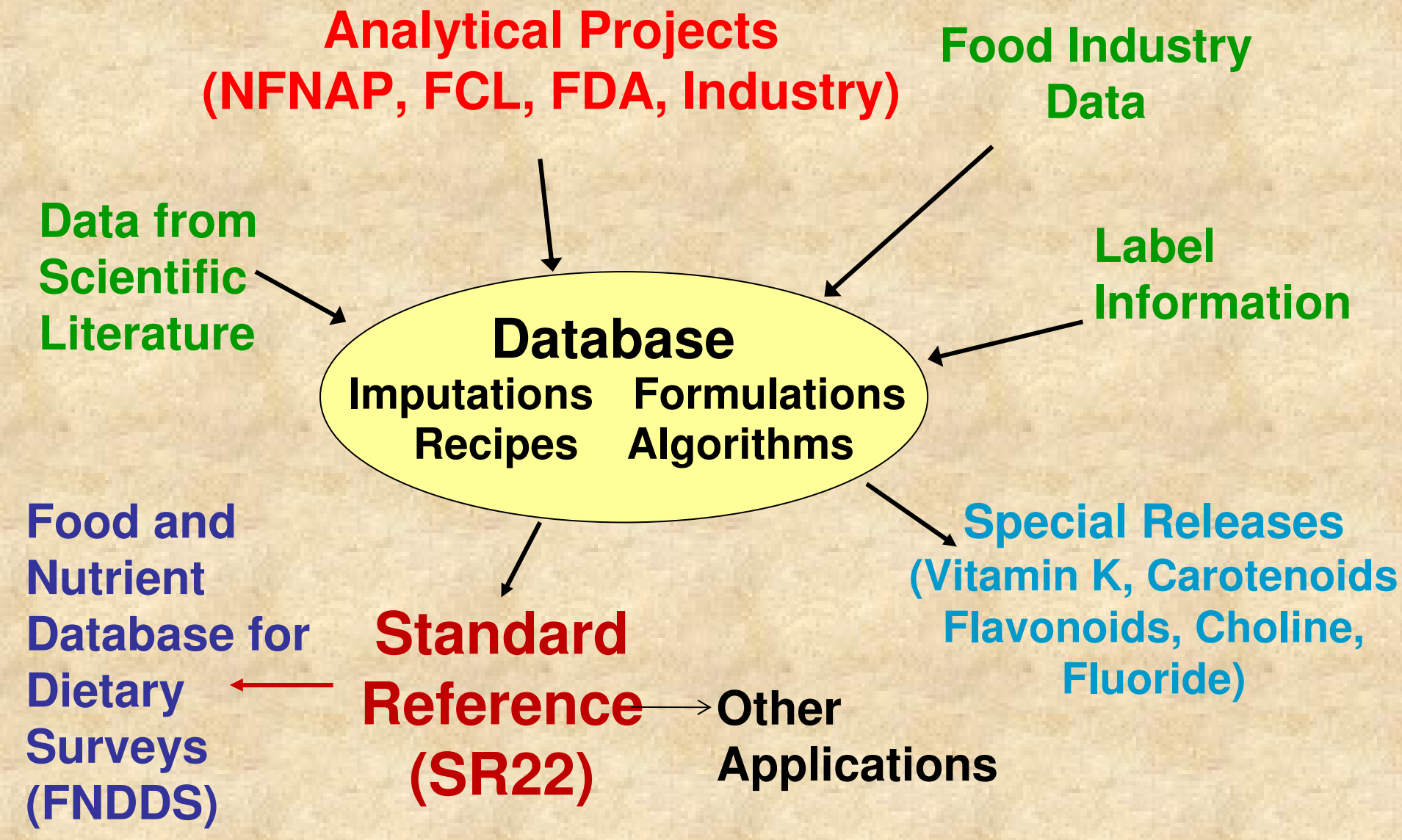
# Traditional Components

- Proximate components
- Amino acids
- Individual fatty acids
- Individual sugars
- Total starch
- Total dietary fiber
- Vitamins (e.g., vitamin A)
- Minerals

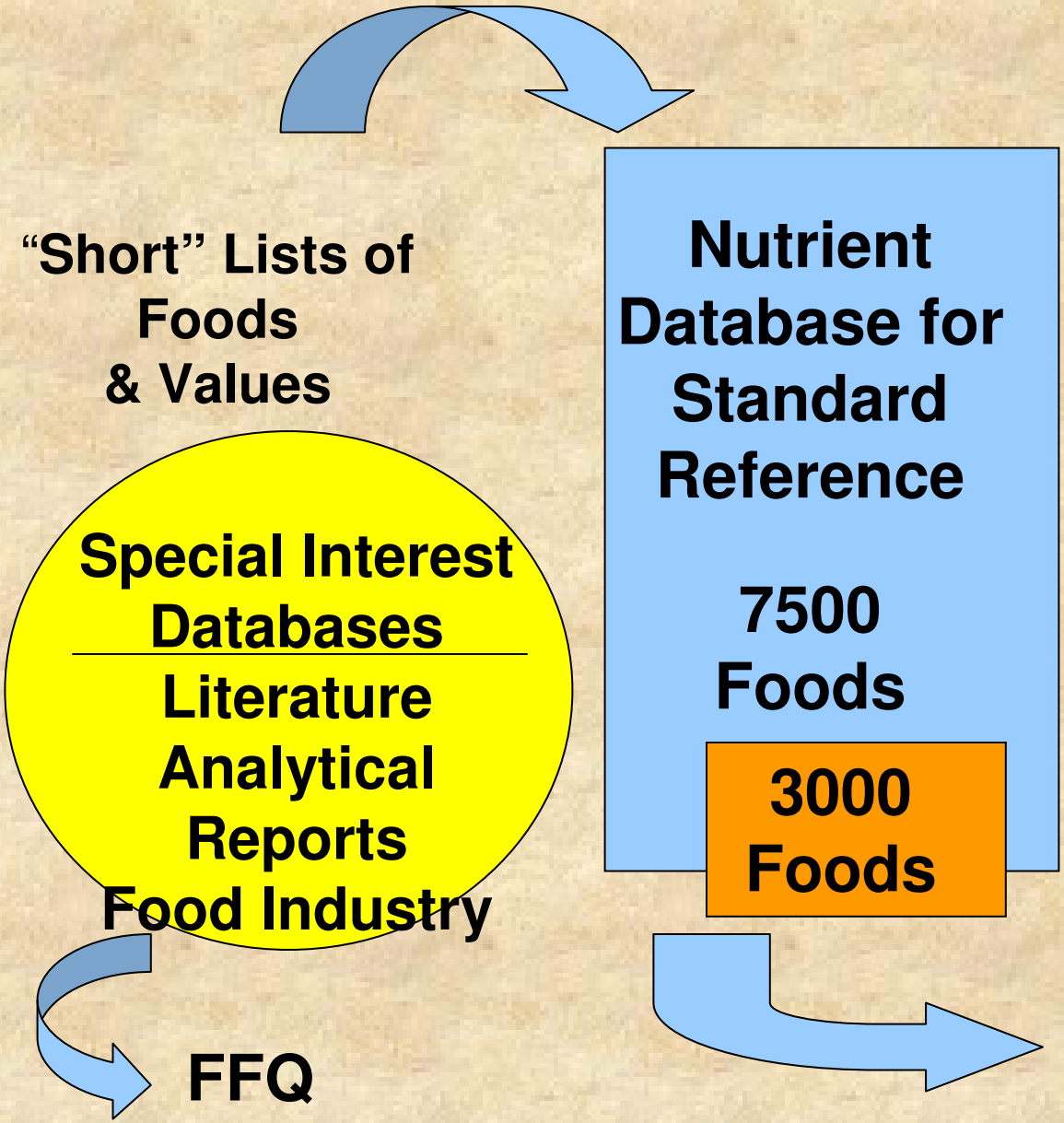
# Emerging Components
## New Analytical Methods
## New functions/New compounds

- Vitamin D?
- Individual Carotenoids
- Isoflavones
- Flavonoids/Proanthocyanidins
- N-3 Fatty Acids
- Choline/Sphingolipids
- Trans-fatty Acids
- Glucosinolates/isothiocyanates
- Other….?

# Sources of Data & Information Flow



# Expansion of Food Composition Databases




**Food and Nutrient Data Dietary System (FNDDS)**

- 7000 "Recipe" Foods reported by Participants
- ~65 Components
- Yield & Nutrient Retention Factors
- All Cells Filled

# Project for Vitamin D Data

## Identified Need for Food and Supplement Composition Data

# USDA Vitamin D Project Plan

| Year 1 – 2005 | Year 2 – 2006 | Year 3 – 2007 | Year 4 – 2008 | Year 5 - 2009 |
|---|---|---|---|---|
| Meeting of Stakeholders | Review Status of Database | Characterize Quality Control Materials | Analyze Food Samples with Quality Control Materials | Impute Values for Ingredients |
| Development of Research Plan | Review of Literature | Qualify Analytical Laboratories | Review Results of Analyses | Impute Values for Multi-ingredient Foods |
| | Identify and Develop Quality Control Materials | Sample Fortified Foods and Fish | Develop and Implement Standard Rules for Imputation | Technical Review of Vitamin D Values in Survey Subset |
| | Initiate Work on Method Improvements | | | Release of Survey Subset to FSRG |
| | Develop Sampling Plan | | | Final Release of SR 22 |

# Acquisition of Data

- The Food Industry provides calculated or analytical data for products
- Industry develops data for up to 14 nutrients (mandatory food labeling)
- Some sectors collaborate with USDA on analytical projects
- Limited data from scientific literature
- Recipe calculation and formulations

# Sources of Data

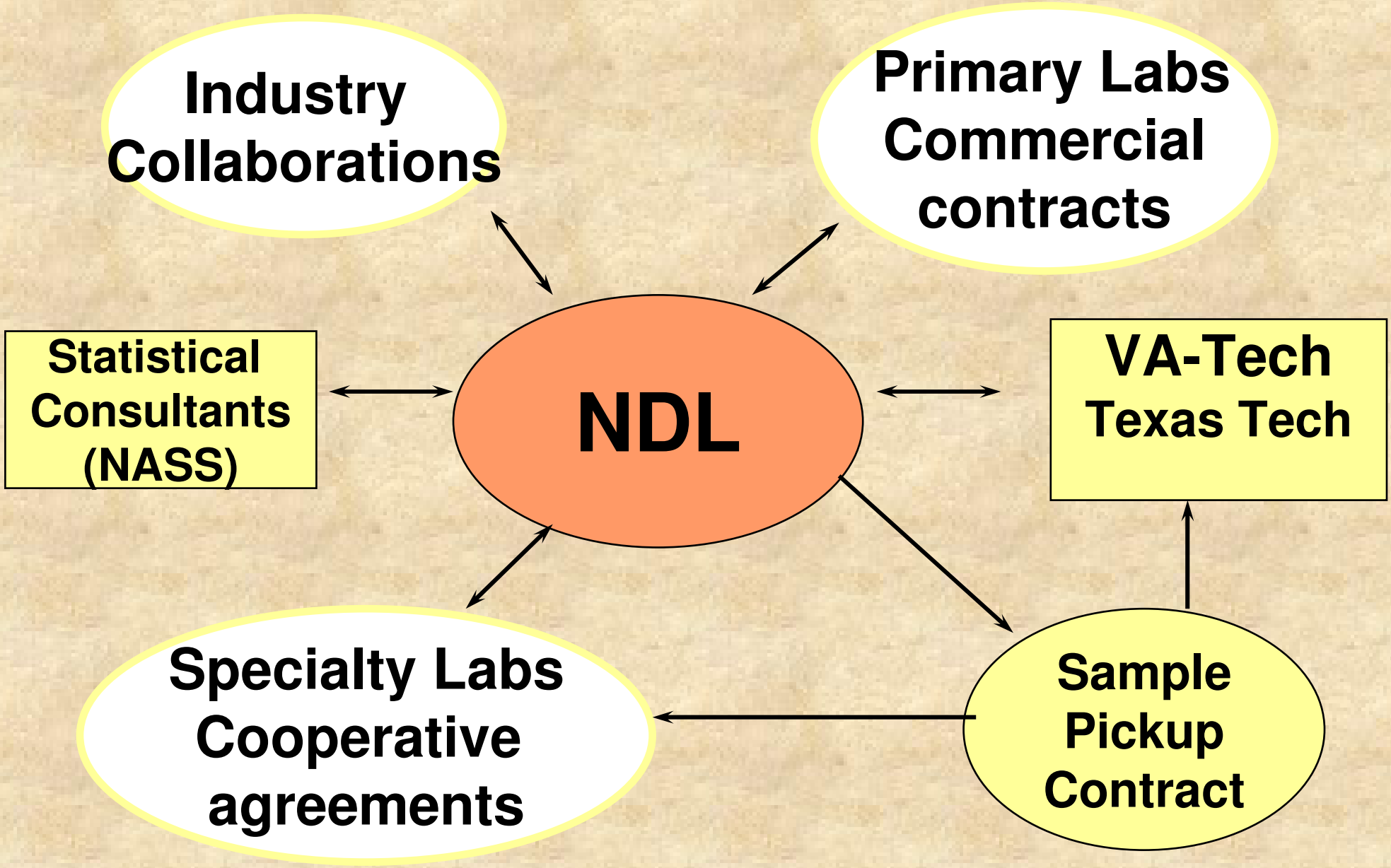
Food Industry
Scientific Literature
Other Government Agencies
Standard Recipes and Algorithms

National Food and Nutrient Analysis Program (NFNAP)

# National Food and Nutrient Analysis Program

- **NFNAP** began in Fall, 1997 with an Interagency Agreement with National Heart Lung and Blood Institute
- National Cancer Institute is now the coordinator with contributions from Office of Dietary Supplements and nine other Offices, Institutes
- Interest in generation of original analytical data with variability estimates for components in foods

# NFNAP Infrastructure



# NFNAP: Aims

- Identify Key Foods and critical nutrients
- Evaluate existing data quality
- Devise and implement a nationally-based sampling plan
- Analyze sampled foods/ valid methods
- Compile and disseminate representative estimates

# What are Key Foods?

**The list of foods which provide about 75% of the intake of a specific component to the diet**

- **Frequency vs. Concentration**
- **Foods alone and as ingredients**
- **Some foods are “key” for several nutrients**

# "Top Ten" Key Foods[1]

- Milk, fluid, 3.25% milkfat
- Milk, reduced fat, fluid, 2% milkfat
- Eggs, chicken, whole
- Rolls, hamburger or hotdog, plain
- Vegetable Oil Spread, 60% Fat
- Beef, ground, regular, cooked, broiled
- Cheese food, pasteurized processed, American
- Orange juice, unsweetened
- Salt, table
- Fast foods, potato, French fried, in vegetable oil

[1] Based on NHANES 2001-2002

# Key Foods - Mixed Dishes[1]

- Pizza
- Spaghetti
- Meat Loaf
- Beef Stew
- Macaroni & Cheese
- Chocolate Cake
- Pot Pie, Chicken / Turkey
- Burrito with Beans & Cheese

[1]Based on the 2001-2002 NHANES: What Do We Eat in America

# Key Foods for Vitamin D

- **Vitamin D fortified foods**
  - Milk: whole, 2%, 1%, skim, 1% chocolate
  - Orange juice fortified with calcium (and vitamin D)
  - Selected yogurts
  - Ready-to-eat breakfast cereal
  - Selected brands of sliced cheese
- **Foods with natural vitamin D**
  - Finfish and shellfish (?)
- **Additional sampling**
  - Eggs
  - Infant formula (fortified)
  - Mushrooms

# Lawful Additions of Vitamin D under GRAS (Generally Recognized as Safe) Regulations [1]

| Category of Food | Maximal level | Estimate of fortified products |
|---|---|---|
| Breakfast cereals | 350 IU/100 g (8.75 mcg/100 g) | Many RTE 63% |
| Grain products and pasta | 90 IU/100 g (2.2 mcg/100g) | Very few |
| Milk | 42 IU/100 g (1.0 mcg/100g) | All |

[1] US-FDA, 21CFR Section 184.1950

# Other Lawful US-FDA GRAS Additions of Vitamin D for Standardized Products

| Category of Food | Maximal level | Estimate of fortified products |
|---|---|---|
| Margarine[1] | 1500 IU /lb (37.5 mcg/454 g) | Few |

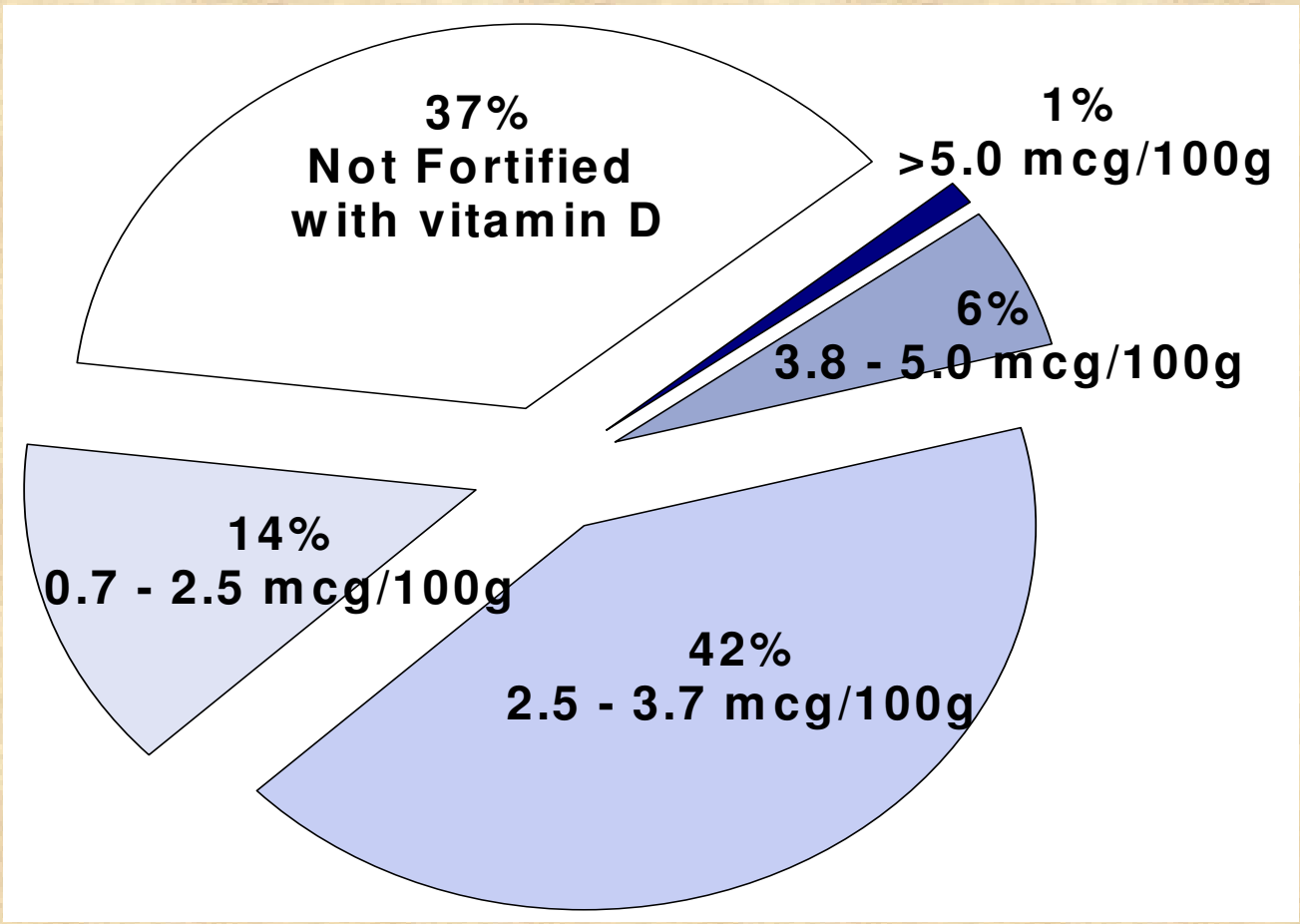
| Category of Food | Minimum – Maximal level | Estimate of fortified products |
|---|---|---|
| Infant formula[2] | 40 - 100 IU/100 kcal of formula (1-2.5 mcg) | All |

[2] 21CFR Part 107 - Infant Formula

# Final Rules on Recent Vitamin D Food Additive Petitions

| Category of Food | Maximal level | Est. of fortified products |
|---|---|---|
| **Calcium fortified fruit juices and fruit juice drinks** | **2.5 mcg/240 mL** | **Ca fortified orange juice** |
| **Meal replacement bars or other-type bars (dietary control)** | **2.5 mcg / 40 g** | **Most** |
| **Soy-protein based meal replacement beverages (dietary control)** | **2.5 mcg/240 mL** | **Most** |
| **Cheese and cheese products (not ricotta, cottage, hard grating)** | **2 mcg / 30 g** | **Few** |

# Vitamin D in RTE Cereals



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# General Process for Evaluating Data Quality

- Were the food samples representative?
- Were the samples handled properly?
- If necessary, were the sample homogenized?
- Was only the edible portion analyzed?
- Were the samples stored correctly?
- How many samples were analyzed?
- Was the analytical method valid?
- Was analytical quality control adequate?

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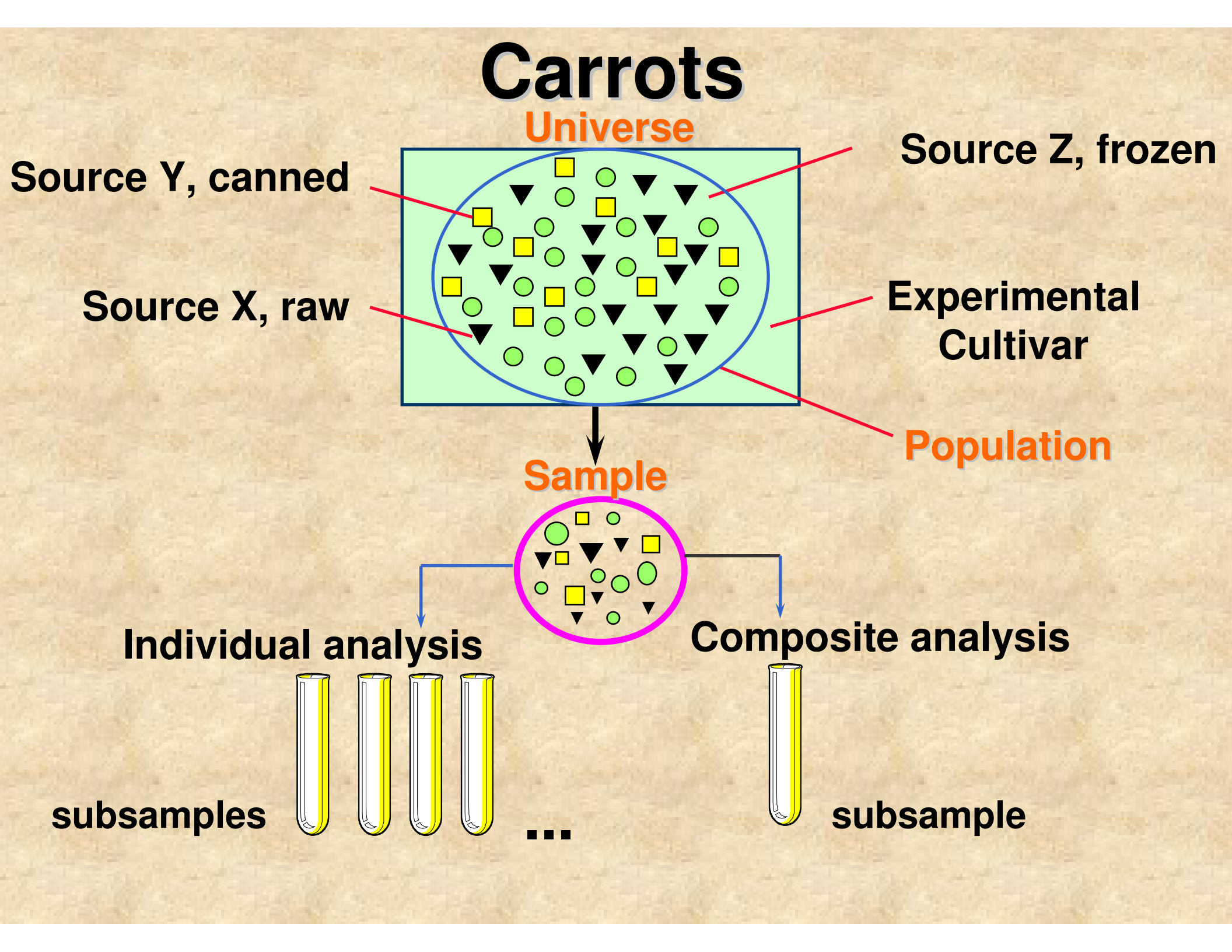
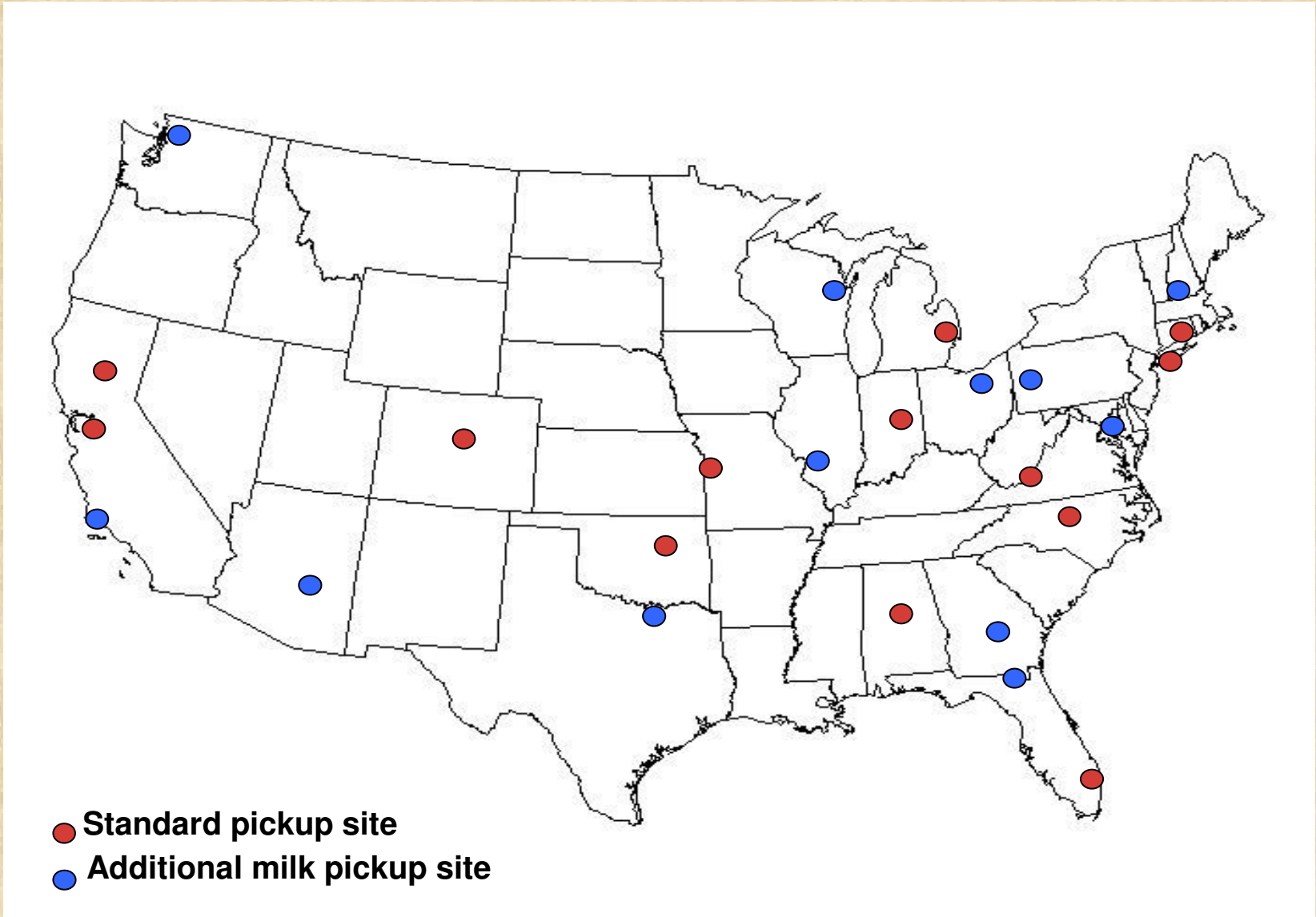
# Carrots


Universe
Source Y, canned
Source Z, frozen
Source X, raw
Experimental Cultivar
Population
Sample
Individual analysis
Composite analysis
subsamples
...
subsample

# NFNAP Sampling Strategy

- Multi-stage Sampling Plan
- Probability (of selection) proportional to size (pps) - 3 stages
- 2000 Census regions, states and counties (48 contiguous states) - rural and urban
- Retail stores with annual sales > $2m
- Brands by market share
- Levels 1 and 2 to be updated with 2010 Census data

# Pickup Locations for Vitamin D Foods



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# Sample Analysis

- Use of valid methods
- On-going quality assurance program
- Development of In-house qc materials
- Qualification of laboratory(ies)
- USDA lab-C. Byrdwell, FCMDL

# Vitamin D Methodology Used

| | Lab D | Lab E | FCMDL |
|---|---|---|---|
| Method Source | Hollis, 2005 (modified[a]) | Hollis, 2005 (modified) | Extraction from AOAC 992.26 (internal standard added) and chromatographic method from AOAC 2002.05 |
| Internal standard | Vitamin $D_2$ | $^3$H-Vitamin $D_3$ | Vitamin $D_2$ |
| Initial extraction solvent | Hexane | Hexane | Ether / petroleum ether |
| Cleanup steps | 3 | 3 | 2 |
| Quantification | HPLC – UV | HPLC – UV + scintillation counting for the IS | HPLC – UV diode array and LC-MS (auxiliary detection) |
| Further confirmation of data | | | LC/MS in SIM mode |

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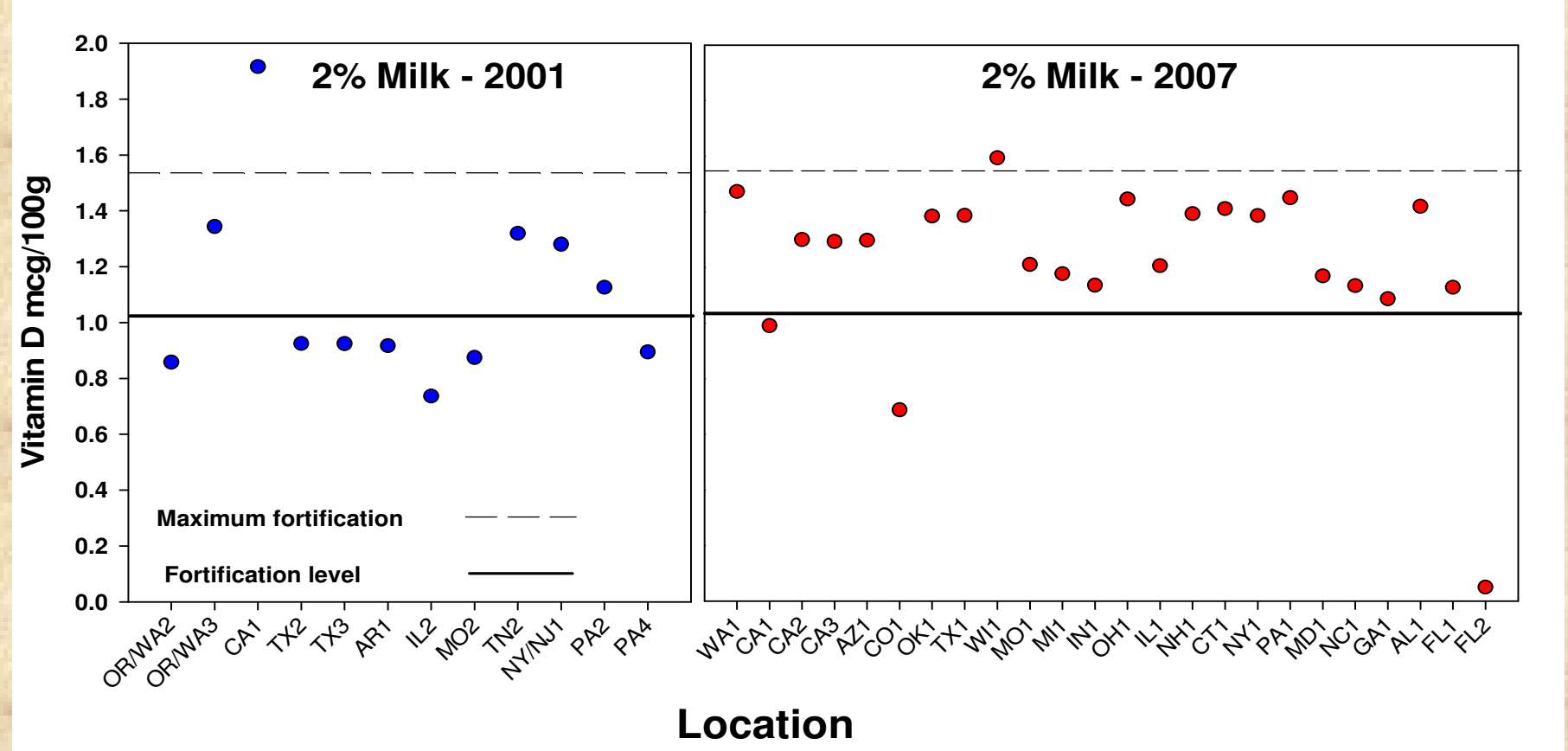
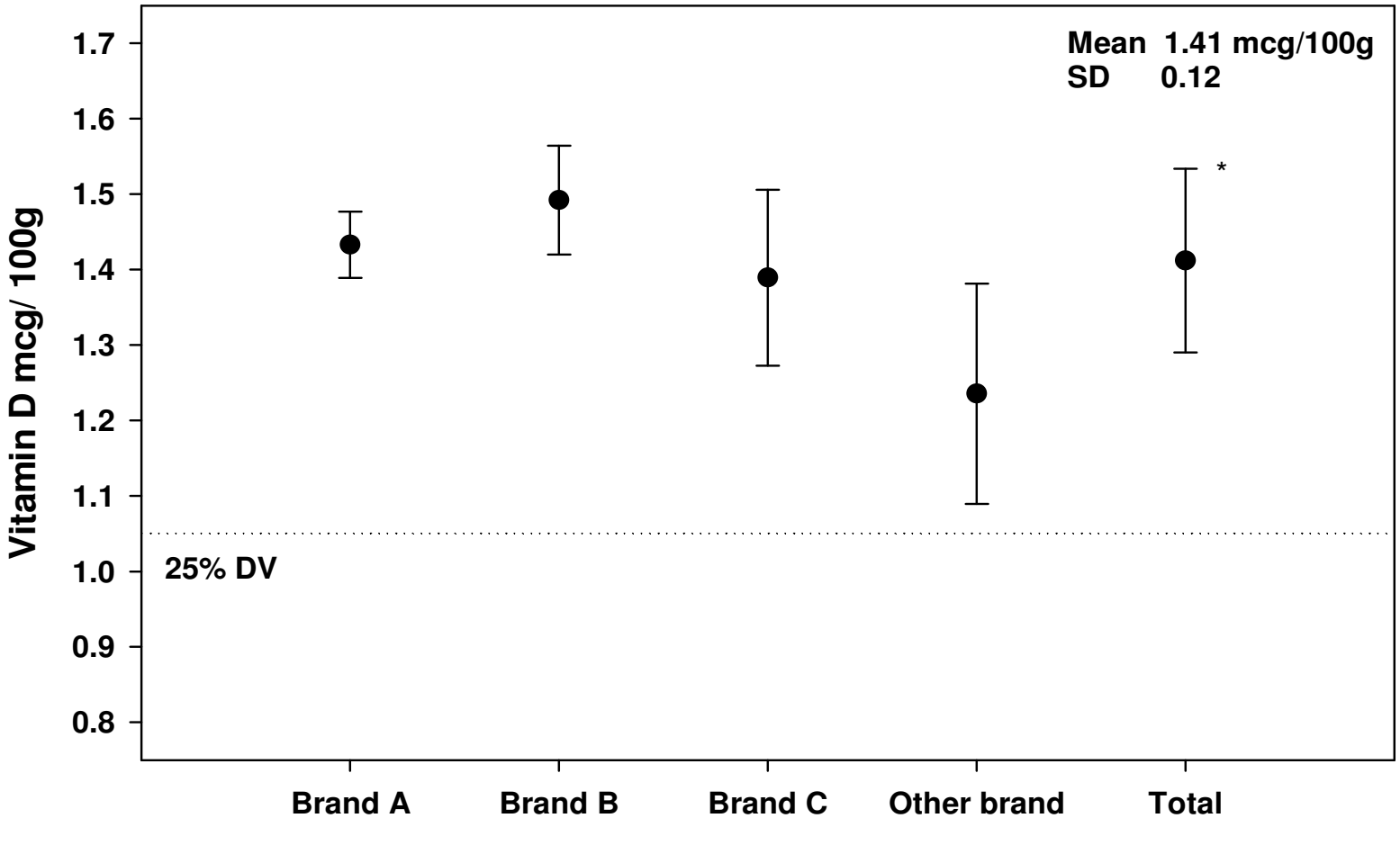
# Comparison of Vitamin D in 2% Milk: 2001 and 2007



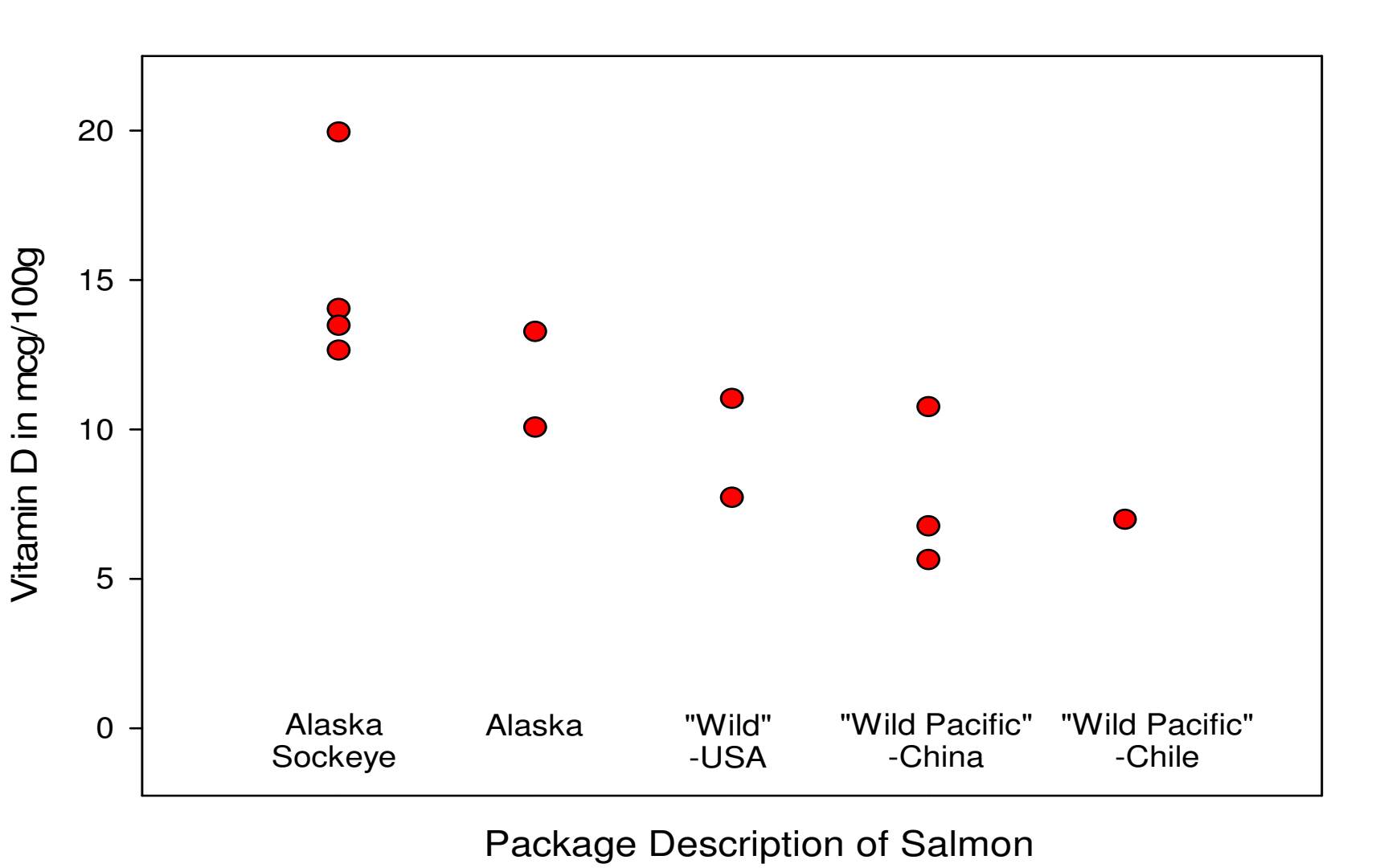
# Vitamin D in Fortified (Refrigerated) Orange Juice



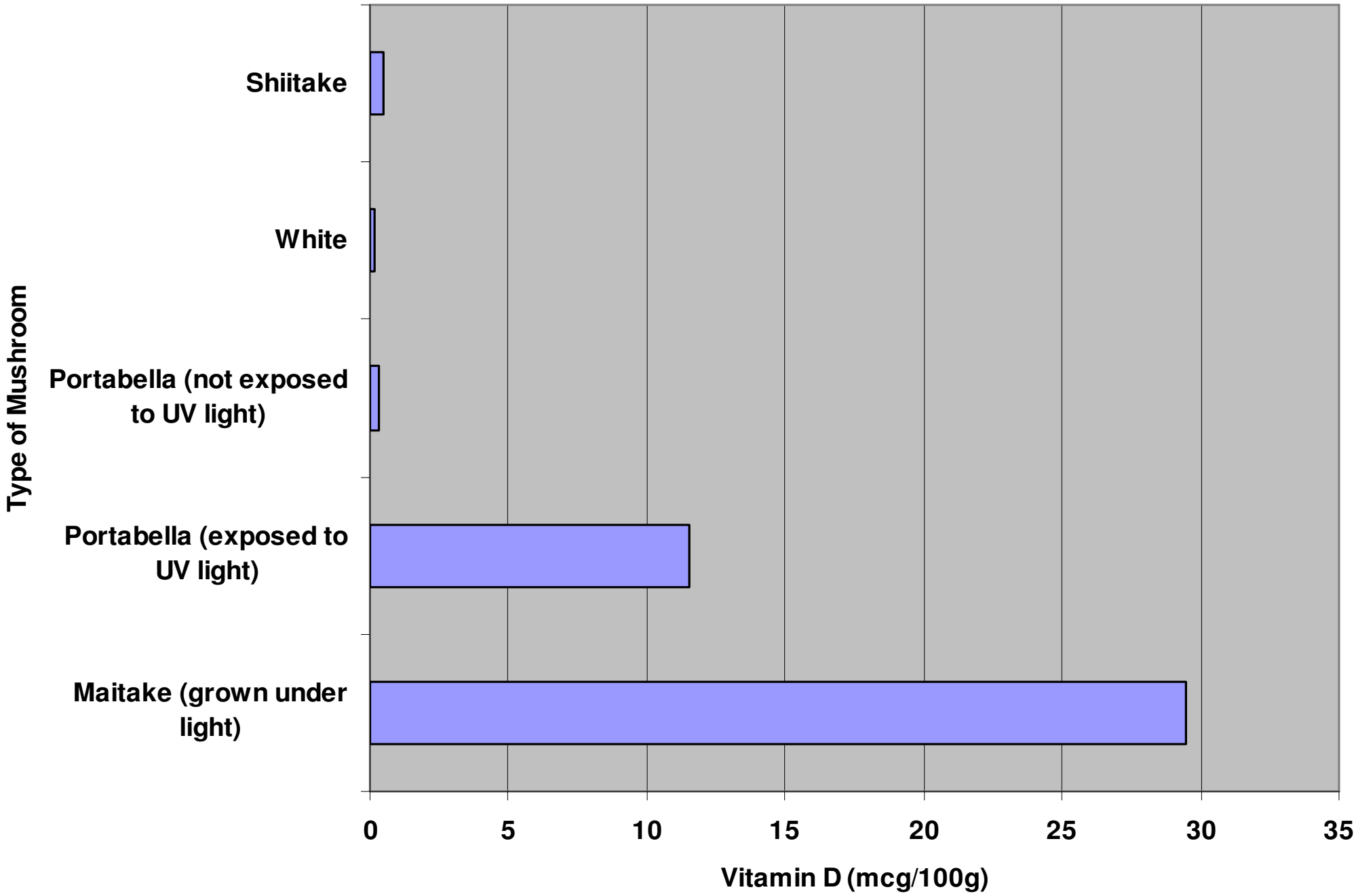

*Omitting sample with no vitamin D, regardless of label

Label Claim .....

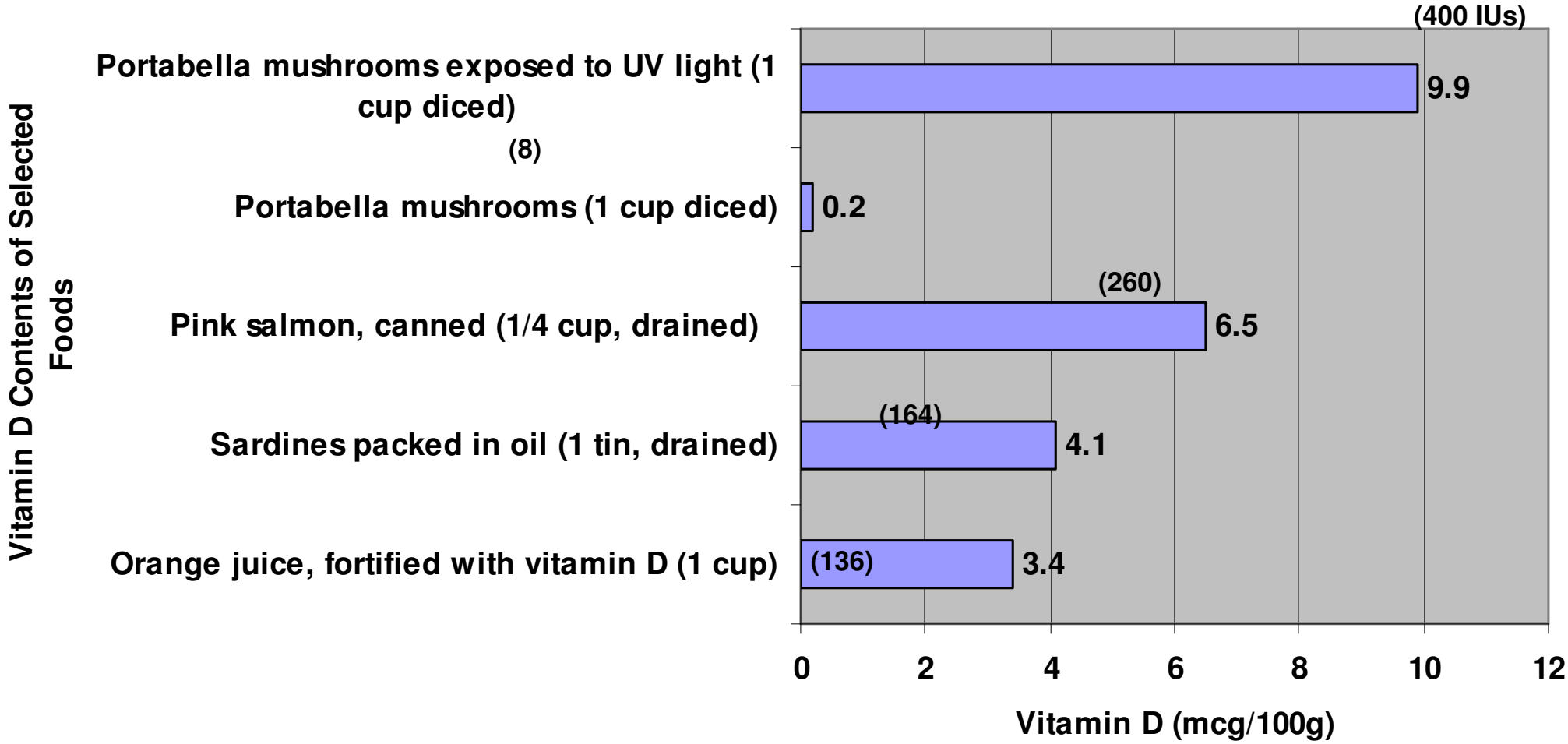
# Vitamin D in Selected Salmon Samples



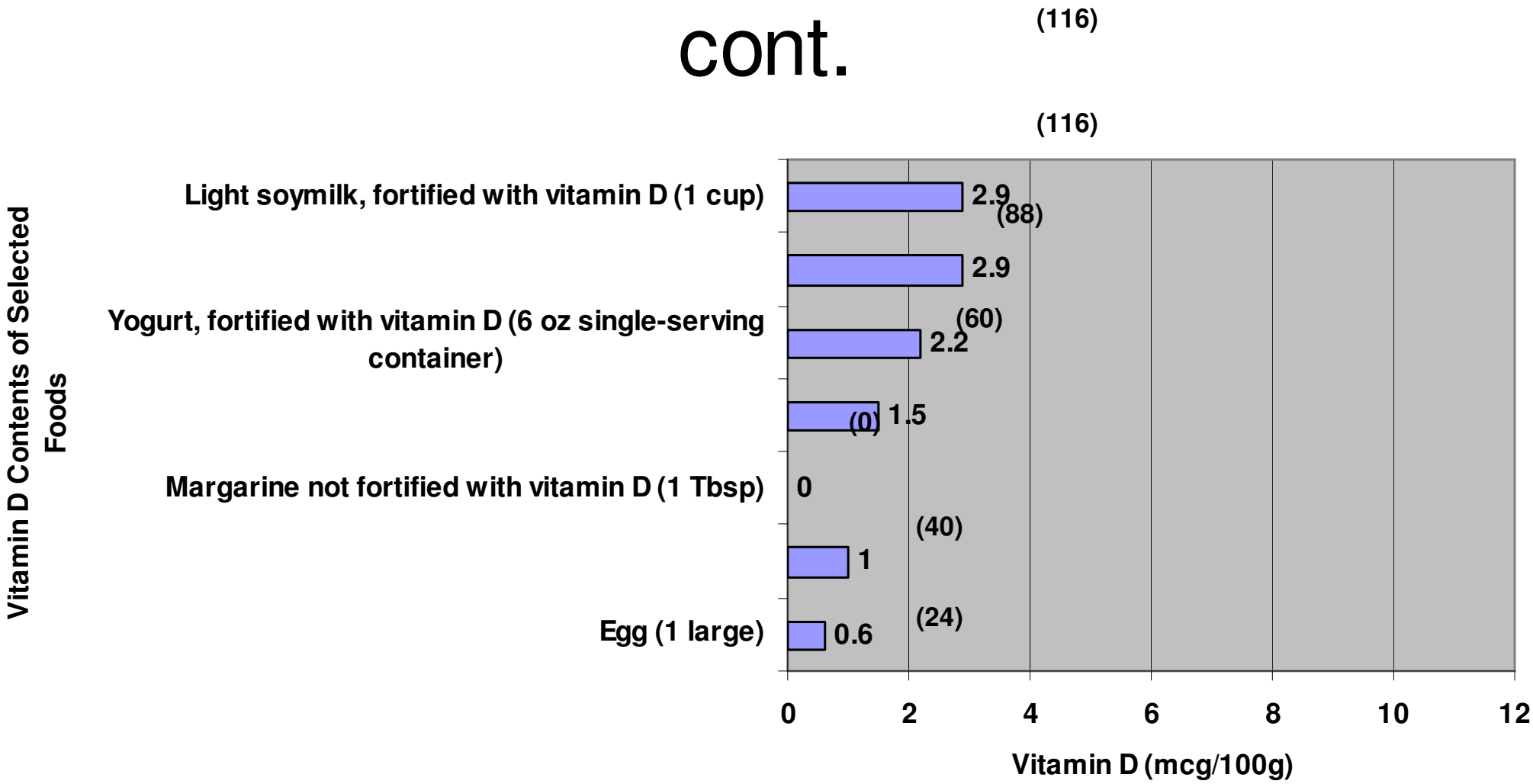
## **Vitamin D in Raw Mushrooms**, cont.



# Vitamin D Values from SR22



# Vitamin D Values from SR22, cont.



# Guidelines for Imputing Vitamin D

- Assign assumed zero for some foods, based on:
  - Food matrix (e.g. fruits unlikely to contain vitamin D)
  - Known values for similar foods
  - Values in foreign food composition tables
- Impute vitamin D for ingredient items required in recipe and formulation calculations.
- Impute vitamin D in multi-ingredient foods by recipe or formulation calculations. Use fortified milk profile only for home-recipe items.

# What Do the Data Represent?

- Estimates of means or central tendency
- Nationally representative of food supply
- Based on high quality analytical data
- Recognized algorithms for calculation and estimation
- Other statistical parameters

# Database for Dietary Supplements

**DSID-1**

- **USDA released the database with analytical verification and estimates derived from regression analysis**
- **2010-Release of Data for Vitamin D**
- **DSID-1 complements NCHS label database**
- **USDA database is available on web site:**

**http://dietarysupplementdatabase.usda.nih.gov**

# Dietary Supplement Ingredient Database (DSID): What is it?

**Database validated by analytical data for key supplement ingredients of public health importance**

**Collaborators**

**Office of Dietary Supplements, NIH**
**National Center for Health Statistics, CDC**
**Analytical Chemistry Division, NIST**
**Food and Drug Administration**

# DSID Home Page


***//dietarysupplementdatabase.usda.nih.gov***

***or***

***//dsid.usda.nih.gov***

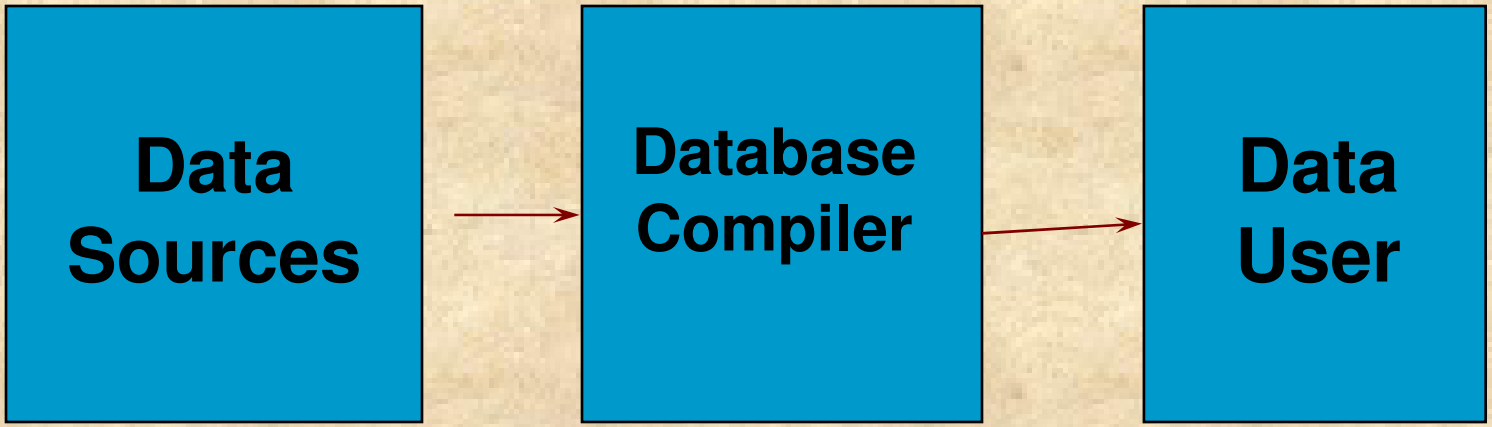
# Conclusions-1

- Original analytical data are an essential part of USDA's food and DS databases
- Since the food/products are dynamic long-term support is required
- New methods, new priorities require continuous monitoring
- Analytical Chemistry: Food Comp. Methods Develop. Lab (USDA)

# Conclusions-2

- Nationwide sampling is critical
- Assurance of Representative Values: Statistical Sampling
- Vitamin D: Intake from foods plus supplements and effects of sun exposure are needed

# Quality Assurance Link



# Financial Support

- Financial support of Institutes (NCI) and Offices (ODS) of the NIH, the USDA, and the US Food and Drug Administration
- Vitamin D-Coca-Cola Beverage Institute for Health and Wellness
- Collaborations with the National Cattlemen's Beef Association, the National Pork Board, and other food industry members

# Thank you!

# Questions?

Agricultural Research Service

USDA