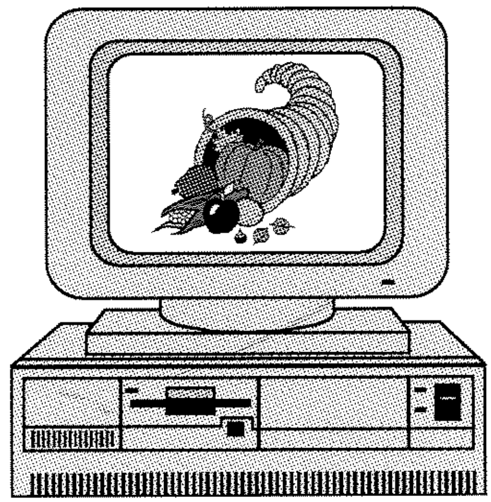
19th National Nutrient Databank Conference Proceedings

Nutrient Data Bases



Responding to Trends & New Technologies

May 22-24, 1994
Regal Riverfront Hotel
St. Louis, Missouri

Edited by Loretta W. Hoover and Betty P. Perloff

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Foreword

The 19th National Nutrient Databank Conference was held in St. Louis, MO on May 22-24, 1994. The conference was planned to address trends in foods and computer technology and highlight some responses to those trends. Several committees of volunteers generously gave their time and expertise to assure a successful and relevant conference. The 1994 Conference Committee Chairs were: Steering Committee, **Al Riley** of Campbell Soup Company; Program Committee, **Betty Perloff** of USDA/ARS/HNIS; Database Committee, **Jack Smith** of the University of Delaware; Communications Committee, **Ruth Matthews** of USDA/ARS/HNIS; and Arrangements Committee, **Loretta Hoover** of the University of Missouri-Columbia. Special thanks go to the rest of the Arrangements Committee: **Catherine Champagne** of the Pennington Biomedical Research Center, **Carolann Davis** of Lincoln University, **Karen Falk** of Graphic Technology, Inc., **E.C. Henley** of Protein Technologies, Inc., **Norma Janes** of Washington University, and **Joy Williams** of the University of Missouri-Columbia who served as Conference Coordinator. In addition, appreciation is expressed to **Evelyn Topper** and **David Wade** of the University of Missouri-Columbia who provided secretarial and audio/visual assistance.

Sincere thanks are extended to **The International Life Sciences Institute** (ILSI) who contributed the cost of printing and mailing the Proceedings of this Conference. Special thanks are extended to **Maureen Griffiths** who, on ILSI's behalf, oversaw the production of the Proceedings.

The experience of previous organizers of the Conference was especially valuable when preparing for this Conference. Special thanks go to **Suzanne Murphy** of the University of California, Berkeley, **Jack Smith** of the University of Delaware, and **Catherine Champagne**, Pennington Biomedical Research Center, Louisiana State University.

This Conference was made possible by funding support by several Federal agencies and corporations. Sincere appreciation is expressed to the following Federal agencies: **Human Nutrition Information Service, Agricultural Research Service, United States Department of Agriculture; National Center for Health Statistics, Centers for Disease Control, Department of Health and Human Services; and Human Nutrition, Agricultural Research Service, United States Department of Agriculture**. Special thanks go to the corporate Sponsors: **The Coca-Cola Company, CPC International-Best Foods Division, Frito-Lay, Inc., The Gerber Companies Foundation, Kraft General Foods, and Nabisco Foods Group.** Also, appreciation is extended to the **Campbell Soup Company and Nestle, USA, Inc.** for their support. Special thanks go to **Allen Foods** and **Anheuser-Busch, Inc.** of St. Louis, MO who provided donations of food and beverages.

Loretta Hoover
Betty Perloff
Co-Editors

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Human Nutrition Information Service,
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The National Nutrient Databank Conference wishes to thank the following sponsors, for their generous and enthusiastic support:

The Coca-Cola Company
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19th National Nutrient Databank Conference

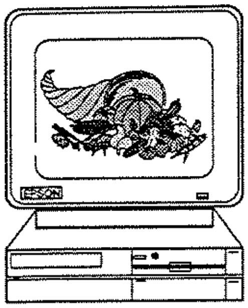
Nutrient Data Bases - Responding to Trends & New Technologies

Final Program

Sunday-Tuesday, May 22-24, 1994

Regal Riverfront Hotel

St. Louis, Missouri



19th National Nutrient Databank Conference

Nutrient Data Bases -- Responding to Trends and New Technologies

Sunday-Tuesday, May 22-24, 1994
Regal Riverfront Hotel
St. Louis, Missouri

Sunday, May 22, 1994

A.M.

10:00 a.m. - 12:45 p.m. **Exhibits Open** .... *Field*

10:00 a.m. -12:45 p.m. **Posters Open** .... *Soulard*

10:00 a.m. -1:00 p.m. **Registration** .... *St. Louis East*

P.M.

1:00 **Welcome** .... *Jefferson D,E,F*
Loretta Hoover, *University of Missouri-Columbia*

1:15- 2:45 **Session 1. Trends in Foods**
Moderator: Catherine Champagne, *Pennington Research Center*

1:15 **Keynote - Trends in Foods**
Bruce Stillings, *National Confectioners Association*

2:00 **How Trends Are Affecting Databases - Panel Discussion**
Betty Perloff, *USDA-HNIS*
Chor San Khoo, *Campbell Soup Company*
Monica Yamamoto, *University of Pittsburgh*

2:45 **Questions**

3:00 **Break** .... *Foyer*
Exhibits .... *Field*
Posters .... *Soulard*

3:30- 5:00 **Session 2. Trends in Computer Technology** .... *Jefferson D,E,F*
Moderator: Catherine Champagne, *Pennington Research Center*

3:30 **Keynote - Trends in Computer Technology**
O. R. (Bill) Plummer, *Ph.D., Professor and Chair, Computer Science, Assistant Vice Chancellor, University of Missouri-Columbia*

4:15 **Using Images in Databases**
Barbara Burlingame, *New Zealand Institute for Crop & Food Research*

4:45 **Questions**

5:00 **Adjourn**

6:15 **User/Vendor Exchange**..*Jefferson D*
Moderator: Phyllis Stumbo, *University of Iowa*

7:30- 9:00 **Welcome Reception** .. *Jefferson E,F*
Ragtime Music by Trebor Tichenor

Monday, May 23, 1994

A.M.

7:00- 8:00 **Exhibits** .... *Field*
Posters .... *Soulard*

7:30- 8:00 **Continental Breakfast** .... *Meramec*

7:30- 8:30 **Registration** .... *St. Louis East*

8:00-10:00 **Session 3. Nutrition Labeling** .... *Meramec*
Moderator: Jean Pennington, *FDA*

8:00 **FDA's Database Review System**
Jean Pennington, *FDA*

8:30 **Industry Databases**

8:30 Databases for Frozen Foods
Robert Garfield, *American Frozen Food Association*

9:00 **Ingredient Databases**
Edward Seguine, *Guittard Chocolate Company*

9:30 **Labeling Regulations and Methods of Analysis**
Jonathan DeVries, *General Mills*

10:00 **Break** .... *Meramec Foyer*
Exhibits .... *Field*
Posters .... *Soulard*

10:30-12:00 **Session 4. New Food Ingredients** .... *Meramec*
Moderator: Grace Petot, *Case Western Reserve University*

Sweeteners
Lyn O'Brien Nabors, *Calorie Control Council*

Fat Replacers, Fat Mimetics, Bulking Agents
Dennis Gordon, *University of Missouri-Columbia*

P.M.

12:00 **Lunch** .... *Mississippi*
Exhibits .... *Field*
Posters .... *Soulard*

2:00- 5:30 **Session 5. Perspectives on Data Quality** .... *Meramec*
Moderator: Suzanne Murphy, *University of California-Berkeley*

2:00 **GAO's Recommendations for Improving Handbook 8**
Betty Perloff, *USDA-HNIS*

2:30 **Sources of Errors and Variation in Nutrient Intake Estimates:**

2:30 **Intake Data Collection and Processing**
Helen Wright, *Pennsylvania State University*

2:50 **Food Composition**
Gary Beecher, *USDA-ARS*

3:10 **Adjusting for Intra-Individual Variability when Estimating Nutrient Intakes**
Patricia Guenther, *USDA-HNIS*

3:30- 4:00 **Break** .... *Meramec Foyer*
Exhibits ....*Field*
Posters .... *Soulard*

4:00 **Perspectives on Data Quality-Panel Discussion** .... *Meramec*
Lori Borrud, *USDA-HNIS*
Margaret McDowell, *CDC-NCHS*
Marilyn Buzzard, *University of Minnesota*
Phyllis Stumbo, *University of Iowa*
Sue McPherson, *University of Texas*

5:30 **Adjourn**

6:60 **Departure for banquet at Missouri Botanical Garden**

7:00- 8:00 **Cash Bar**
Walk Garden Grounds

8:00 **Dinner**

Presentation: **Biodiversity: It's Meaning to Us**
Dr. Peter Raven, *Director, Missouri Botanical Garden*

Tuesday, May 24, 1994

A.M.

7:00- 8:00 **Exhibits** .... *Field*
Posters .... *Soulard*

7:30- 8:00 **Continental Breakfast** .... *Meramec*

7:30- 8:00 **Registration** .... *St. Louis East*

8:00-11:30 **Session 6. Nutrition Monitoring Updates** .... *Meramec*
Moderator: Wayne Wolfe, *USDA-ARS*

8:00 **Nutrient Composition Laboratory**
Gary Beecher, *USDA-ARS*

8:20 **USDA Nutrient Databank**
David Haytowitz, *USDA-HNIS*

8:40 **Food and Drug Administration**
Jean Pennington, *FDA*

9:00 **The Dietary and Nutritional Status of Americans: What the Nutrition Monitoring Program Shows**
Debra Reed, *USDA-HNIS*

9:30-10:00 **Break** .... *Meramec Foyer*
Exhibits .... *Field*
Posters .... *Soulard*

10:00 **NHANES** .... *Meramec*
Margaret McDowell, *CDC-NCHS*

10:30 **CFSII/DKKS**
Lori Borrud, *USDA-HNIS*

11:00 **International Nutrient Database Activities**
Joanne Holden, *USDA-ARS*

11:30 **Lunch** .... *Lewis/Clark*
Exhibits .... *Field*
Posters .... *Soulard*

P.M.

1:00- 4:00 **Session 7. Data Base Maintenance Issues** .... *Meramec*
Moderator: Betty Perloff, USDA-HNIS

Selecting a Database Management Software
Brian Westrich, *University of Minnesota*

Software Testing Requirements
Judi Douglass, *Technical Assessment Systems*

A New Recipe Calculation Model
Loretta Hoover, *University of Missouri-Columbia*

Using the New USDA Formats
Lois Steinfeldt, *University of Texas*

Strategies for Adding and Documenting Data for New Foods
Gail Harrison, *UCLA*

Closing Remarks

4:15 **Adjourn**

POST CONFERENCE ACTIVITIES
(ticket required)

Tuesday, May 24, 1994
St. Louis Cardinal Baseball at 7:05 p.m.

Wednesday, May 25, 1994
Monsanto's Life Sciences Research Center
Depart the hotel lobby at 8:15 a.m. with return via St. Louis Airport by 12:15 p.m.

TRENDS IN FOODS

Trends in Foods
Bruce Stillings, *National Confectioners Association*

How Trends Are Affecting Databases - Panel Discussion
Betty Perloff, *U. S. Department of Agriculture,*
Agricultural Research Service-Human Nutrition Information Service
Chor San Khoo, *Campbell Soup Company*
Monica Yamamoto, *University of Pittsburgh*

Trends in Foods

Bruce Stillings, Chocolate Manufacturers Association;
National Confectioners Association

The subject of "nutrient databanks" is particularly timely and of high interest with implementation on May 8 of NLEA. This topic is also a complex and changing one as witnessed by the fact that there have been 19 of these conferences. The complexity, certainly, is influenced heavily by changes that are occurring in foods and the food industry and will be to discuss some of the major trends in fools and to speculate on some of the changes that we may face in the future. I'm going to touch on 7 key trends, and then will summarize and highlight the implications of these trends on nutrient databases.

Industry Consolidation

Perhaps no one activity has affected the food industry more over the past decade than **mergers and acquisitions.** Particularly since the early 1980's, the industry has been turned upside down and inside out by thousands of such changes in business related to food.

As shown in Figure 1, since the mid 1980's mergers and acquisitions for all food related businesses have **averaged around 600 annually.** These businesses include food processors, suppliers to the food industry, food service firms, retailers and others. The numbers dropped from 1988 to 1991 but mergers and acquisitions have been on the increase over the last two years. Of particular interest to us, **food processing firms** account for about 20% of total mergers and acquisitions. While during the middle and late- '80s there were over I 00 mergers and acquisitions annually, the numbers decreased from 1988 to 1990 but also have been on the increase over the last 3 years. I think the magnitude of these numbers is truly astounding and reflects the kinds of changes and turmoil that are occurring in the food industry. In turn, these changes impact the products that are developed and marketed and on which nutrient databases depend.

These kind of changes also have major impacts on the make up of the food industry, and there tends to be a concentration of power and resources as larger firms swallow smaller ones. As shown in Table 1, the **top 16 food companies** in the U.S. all have worldwide **food sales over 5 billion dollars** ranging from 33 billion for Philip Morris to just over 5 billion for General Mills. These 16 companies account for a total of about 175 billion dollars in worldwide sales, compared to the food industry sales of just over 400 billion dollars in the U.S.

This concentration also tends to result in stronger R&D functions in the larger companies in which the critical mass is large enough to support extensive basic research programs. This tends to result in greater product innovation and product proliferation in the marketplace.

In general, the consolidation and concentration that is happening in the food industry is tending to **divide the industry into two groups.** First, there are those companies that can afford to develop technologically innovative products and will more likely be market leaders. Second, there are those smaller companies that will have difficulty competing technically and will tend to be market followers searching particularly for market niches.

New Product Introductions

Let's take a look now at how food companies have been doing in the marketplace in **introducing new products.** Figure 2 shows the number of new food and beverage products introduced over the last 8 years. As is evident, there was a doubling of new products introduced from 1986 to 1991 when a total of 12,398 were introduced. Over the past 2 years, introductions have been relatively flat with a **total of 12,897 introduced in 1993.** I should note that the numbers on this slide, although reported as new products, are actually new SKUs (Store Keeping Units) introduced. For example, if a new product is introduced in 2 package sizes, each would be classified as a separate SKU and would be counted as 2 new products. The number of actual new products is probably closer to 5,000 to 6,000. Anyway you look at it, however, this influx of new products into the marketplace is truly remarkable and again, highlights the complexity and changes that are occurring. It also starts to put into perspective the difficulty in developing and maintaining nutrient databanks that are going to reflect adequately the new ingredients and new products entering the marketplace.

With the changes that have occurred in the total number of new food products introduced, the question is **what's likely to happen in the future?** I think the fact that we're seeing a leveling off of new introductions reflects the impact of at least three factors. **First,** the economy affects new product introductions because it's expensive to develop and market new products. **Second,** the changes in the regulatory environment certainly have impacted new products. As we'll see in a few minutes, NLEA apparently has had a dramatic affect on new products introduced with health claims. **Thirdly,** product introductions are leveling off because of a saturation in the marketplace and a limitation in the numbers that retailers can absorb. It's likely we'll see a continuing slight increase in new food product introductions but nothing like the acceleration that was witnessed in the second half of the 1980's.

If we next look at the **categories which these new products represent,** we see in Table 2 that over the last 6 years:

- Introductions of **new baby food products have been relatively low** and in 1993, they dropped to an unbelievably low total of 7 in 1993. Considering the modest baby boom underway these days, it's amazing that so few new items were available to tempt tots and parents.

- There continued to be a **sizable number of bakery products** introduced but the numbers were down slightly in 1993 from 2 years previous. "Fat free" products continued to dominate new bakery foods introductions including new line extensions introduced by Nabisco to take advantage of the success of its multi-million dollar Snackwell's brand. On the other hand, mini-size cookies and crackers, which were the rage a few years ago, took a dive when consumers realized they were ingesting more calories by eating handfuls than when they ate regular size cookies.

- **Baking ingredients have remained relatively stable** over the years with 383 introduced in 1993. These include: bread making mixes and special yeasts to take advantage of rising sales in bread machines. Also, several new ingredients for dessert mixes were introduced to take advantage of several name brands such as Oreo's, Reese Pieces, M&M's, and so forth.

- **Beverage introductions continued to take off** in 1993 accounting for 1845 new introductions. These included scores of flavored waters, seltzers and juice drinks as well as water from virtually every natural water spring in the world. Also within the beverage category, "ice" beers were hot while cocoa mixes made a comeback with upmarket lines introduced by several chocolate companies.

- Over the years, there has **not been much change in breakfast cereals** with about 100 introduced annually. Since a I percent share in the breakfast cereal market is worth about $80 million in annual sales, one would expect cereal companies to be more aggressive in introducing new products. However, in 1993, there were only 5 major brand introductions; the rest were line extensions.

- **Manufacturers were aggressive, however, in introducing new candy, gum and snacks** with the number almost doubling from 1987 to a high of over 2000 in 1993. On the other hand, in a country with so many chocoholics, it's a surprising how few major chocolate bars are introduced each year. 1993 was no exception with only the Nestle's Aero and Hershey's Reese's Nutrageous bars new in the chocolate covered bar scene. The high number of total new products introduced in this category reflects the high number of very small snack and confectionery companies in the U.S.

- **Another very aggressive category is condiments** where total introductions have risen by 130 percent over the past 6 years to a high of 3148 in 1993. This, by far, is the most aggressive category in terms of new product introductions. New product developers were busy in 1993 introducing every conceivable type of new salsas, salad dressings, barbecue sauces, spices and a variety of other condiments.

- **Dairy products are also an aggressive category** but new product introductions have tended to decrease in recent years. The continuing consumers concern with fat and cholesterol was reflected in 1993 in the introduction of scores of low fat, reduced fat, or no fat milks, sour creams, yogurts, creamers and cheeses. This category also included dozens of new ice cream novelties, flavored coffee creamers and major new dairy brands including Fleishmanns low fat and Carvel.

- **Desserts tend to have relatively few new entries.** However, there have been major increases over the last 3 to 4 years.

- **Entrees have been relatively stable** over the last 6 years with the exception of a major increase in new brands introduced in 199 1. In 1993, companies were content merely to add new varieties and to consolidate and nationalize their lines.

- **Pet foods are also included** under new product totals. We will not spend any time discussing pet foods except to note that virtually every variety and flavor available in human foods is also available in pet foods.

- **Processed meat products took a dramatic drop** in new entries in 1993, possibly influenced by the continuing trend toward lighter and healthier foods. The new products in this category were often "light" in nature and also included several meat substitute based products.

- **Of 680 new side dishes** introduced in 1993, 522 of these were new pasta products. In terms of **new entries in soups,** this category has been **relatively stable** over the years.

Next, let's look at where these new products are coming from. Table 3 shows the **15 companies that introduced the greatest number of new products** in 1993. You'll note that Nestle took over the number I spot from Philip Morris who had been the leader the previous year. Other heavy contributors to the grocery shelves included: ConAgra with their Healthy Choice line of products, Campbell Soup, and Wessannan USA, which is the U.S. subsidiary of a Dutch company that manufactures and markets several lines of condiments and health foods. It's interesting to note that these 15 top companies introduced a total of 1,350 new products, which is still only about 10 percent of total introductions. This indicates that there are high numbers of small companies involved in introducing a wide variety of new products.

With this high amount of new product activity going on, the food industry is faced with a perplexing challenge, On the one hand, there is an ongoing expectation and demand to create new break-throughs and an ever increasing number of new products. On the other hand, the success rate is hardly encouraging. For example, one estimate indicates that only one half of one percent of new product introductions achieve annual sales in excess of 25 million dollars. Put another way, of the more than 5000 actual new products introduced in 1993, only about 25 are estimated to have annual sales of more than 25 million dollars. This is a remarkably small number for an industry with sales of more than $400 billion.

I think it tends to validate the **"share of stomach" principle.** In other words, total amount of food consumed in the U.S. is relatively constant and food manufacturers are vigorously competing for an increased share of stomachs. As mentioned earlier, I think it unlikely that the food industry will continue to introduce new products at the same rate in the future. It's more likely that we'll see a reduced rate of new introductions and hopefully an increased success rate.

Diet and Health Recommendations.

Having now looked at the new products that industry is selling, I'd now like to turn to **what health professionals are telling us** that we should be eating and subsequently, we'll look at food consumption trends and what we actually are eating. Since 1977, there have been no fewer than **15 sets of dietary recommendations** from government, health organizations and the National Academy of Sciences (NAS). There was the original Senate Select Committees Dietary Goals in 1977, the Surgeon General got into the act in 1979 and 1988, USDA has issued updated Guidelines in 1990 and Guidelines of one sort or another have been issued by the American Medical Association (AMA), American Cancer Society (ACS) and American Heart Association (AHA). In addition, the National Academy of Sciences has issued at least 4 sets of recommendations.

Although the recommendations vary to some degree, there is fortunately a **degree of consistency** running through the various guidelines and recommendations. The multitude of recommended dietary changes and their link to various diseases can perhaps best be summarized by focusing on the **1988 Surgeon General's report** (Figure 3). The report stated that we should reduce fat to 30% or less of total calories and control the number of calories consumed. These changes were aimed at reducing the risk of heart disease, cancer, stroke, diabetes and gastrointestinal diseases. The report also recommended an increase in consumption of starch and fiber by eating more fruits, vegetables and complex carbohydrates such as breads, cereals and legumes. These changes should help reduce the risk of cancer, diabetes and gastrointestinal diseases. In addition, a reduction in consumption of sodium should help reduce the risk of heart disease and stroke, while controlling intake of alcohol should reduce the risk on cancer, stroke and gastrointestinal diseases.

I believe that all of these **dietary recommendations,** which began to appear 17 years ago, have helped to **spark the high interest in healthy foods** and the trend by industry to jump into the health claim race.

Changing U.S. Diets

As health professionals have been proclaiming what the American consumer should eat, and as industry has been introducing an ever increasing number of new products, let's take a **look at the changing** U.S. **diet** and what the American people are actually eating.

First, from a macro viewpoint, over the past 40 to 50 years we've seen major decreases in per capita consumption of eggs and dairy products, while meat, poultry and fish have increased by over 60 percent. Actually, red meat consumption has fallen slightly in recent years while poultry has increased by over 400 percent. In respect to fats and oils, Americans have steadily increased their overall consumption of fat while substituting vegetable for animal fat. Consumption of animal fats has declined especially since 1940 and vegetable oil consumption has increased steadily since 1909.

If we look more closely at **changes in diet compared to dietary recommendations, we find several favorable trends** that are consistent with the dietary guidelines (Table 4). For example, consumption has decreased for cholesterol, whole milk and red meat, while there have been increases in consumption of low-fat milk, chicken, pasta and fresh vegetables. These are all trends in the right direction, to be consistent with recent dietary recommendations. There are also, however, **several trends that are not necessarily consistent** with dietary recommendations. For example, per capita consumption of calories in 1990 compared to 1960 was up to 14 percent. Others:

-Fat up 14 percent
-Potato chips up 50 percent
-Fats and oils up 35 percent
-Alcoholic beverages up 29 percent

Thus, the data seem to indicate that consumers are interested in healthy eating to a point, beyond which several other factors come into play to influence food choices.

Changing Consumer Attitudes

I want to touch very briefly on consumer attitudes and behavior concerning nutrition and diet. The comments I'm going to make are from the recently released publication from the Food Marketing Institute entitled "Trends 94". This study was the 23rd in a series of consumer attitude surveys begun in 1973. Data for the survey were based on interviews with over 2000 male and female supermarket shoppers. In the survey conducted in January and February of this year, **66 percent of respondents felt that their diet could be** somewhat or a lot **healthier.** This number has not changed significantly over the past 4 years. To a similar question, 62 percent indicated that they were very concerned about the nutritional content of the food they eat and this number is not greatly different from those in surveys over the last 3 or 4 years.

What did change however, was the **nature of the concern about the nutritional content of diets.** As shown in Figure 4, the percent of consumers concerned about the fat content of foods has increased dramatically since 1986 to a high of 59 percent in 1994. These figures reflect the consumer demand for reduced and low fat products that food companies are attempting to meet.

Interestingly, concerns about cholesterol levels have decreased over the last 4 years. I suspect that these results reflect the confusing message that consumers receive through the media about which foods raise and which foods lower cholesterol. There has been so much confusion in recent years, consumers may simply be discounting this as an important nutritional issue to be concerned about. Also, as shown in the graph, consumer concern about salt content of foods has also decreased in recent years as has their concern about sugar, which is not shown here.

Let's look now at **what consumers are** reportedly saying they're **doing about changing their dietary behavior.** As shown in Table 5, 94 percent in 1994 say they have changed their eating habits to help ensure a healthful diet. This is a trend which has been increasing since 1990, and eating more fruits and vegetables has been the primary way that shoppers ensure themselves a healthful diet. About a third of consumers report that they are consuming less fats and oils, which is up significantly since 1992 and 1990 and consistent with consumers' nutrition concerns. Results on cholesterol also are consistent with those reported earlier; only 3 percent say they are changing dietary behavior to reduce cholesterol intake, which is down significantly from the 15 percent in 1990. Also note, that fewer consumers report that they're changing their diets to include more fish, more fiber and less salt.

In summary, these results seem to show that consumers still have a **desire to improve the nutritional quality** of their diets and many consumers are indeed changing their diets by increasing their intakes of fruits and vegetables and decreasing fats and oils. Beyond these components, however, consumers seem to be less concerned and are making fewer changes in their dietary behavior.

Another change in consumer behavior is the switch to store or lower priced brands instead of national brands. In the FMI Survey, 18 percent of consumers said that they buy private label brands every time they shop, and 89 percent do so at least occasionally.

As shown in Table 6, this behavior is reflected in the **high market share for private label products** in several key categories, including dairy, frozen vegetables and juices and fresh bread and rolls. On the other hand, penetration of private label brands is relatively low in many other categories including cookies, beverages, snacks, coffee and cereals.

Healthy Foods

Without a doubt, the **greatest change** that has occurred in foods over the past decade **has been the obsession with so-called healthy foods** and there is good reason for all the hype and hoopla with healthy foods. The reason these products sell is because consumers are demanding foods that they perceive to be healthier, that make them feel better, and that make them look better.

Let's now look at the **number of new products introduced in 1993 bearing health claims** (Table 7). I'm sure that it's not a surprise to see that reduced and low fat and calorie products are at the top of the list. Consumers want products that contain fewer calories, less fat, and lower cholesterol, and this is a trend that will undoubtedly continue for the foreseeable future. Please note that there were about 1,740 new products with reduced calorie, fat or cholesterol claims or close to 14 percent of all new products introduced in 1993.

A **second major category** of new products are those with claims for **no additives or preservatives, all natural or organic.** The high interest in these products is at least partially fueled by negative consumer reaction to pesticides and additives in general, as well as the masterful job that the food industry has done in moving effectively to meet the demand for all natural products. The high interest in these types of products will undoubtedly continue for the immediate future. At some point, however, I would hope.- and expect that consumers will be better educated and come to understand that all natural-type products are not necessarily more healthy or safer products.

As indicated in Table 7, there continues to be consumer interest in and demand for reduced and low sugar and salt products, and to a much lesser extent, for added or high fiber and calcium products. This relatively low demand for high fiber as well as high calcium products is a major change from 5 to I 0 years ago. Using this as a benchmark, it's conceivable that the interest in low fat, low calorie and all natural products may diminish substantially 5 and I 0 years into the future.

Having taken a look at the numbers of new products bearing health claims introduced in 1993, let's now look at the **trends that have occurred over the last 5 to 6 years in these same products.** As noted in Figure 5, there have been dramatic changes in products with health claims related to low calorie, fat, and cholesterol. These health claims increased markedly from 1988 through early 1990's. **However, all 3 showed a dramatic decrease in 1993.** I believe that this decrease is not by any means due to lack of consumer demand for healthy foods; instead, it appears that these decreases reflect the impact of the NLEA. As you know, NLEA rather severely restricted the types of claims that can be made on products and although not fully implemented in 1993, I suspect that the food companies were labeling new products in anticipation of full implementation in 1994.

In Figure 6, the same trends can be seen with all natural, no additives or preservatives and organic claims. There were increases from 1988 to the early 1990's and then that **dramatic decrease occurred in 1993.** Similar trends can be seen in Figures 7 and 8 for reduced salt, high fiber, low sugar and high calcium products.

The enormous reduction in products bearing health claims that were marketed in 1993 is probably one of the **most dramatic changes that has occurred recently** in the food industry. It indicates that manufacturers have modified their claims as well as formulations for new products to comply with NLEA. I suspect that there will be increases in the years to come in products bearing health claims, but much more modest and lower in number than have occurred prior to NLEA.

New Fat Ingredients and Technologies

Clearly, **advances in technology and new ingredients are a driving force** behind the development of quality fat- and cholesterol-reduced foods, and the market for these types of foods is driven by high consumer demand. As this demand increases and new fat replacers become more widely available, the food technologists has a major challenge to deliver well-rounded flavor and mouth-feel in new products as well as reduced fat and calories.

Fat replacers can be classified into two distinct categories: mimetic and substitutes. Each has its own characteristics. Fat mimetics are compounds that help replace the mouth-feel of fats but cannot substitute for fat on a pound for pound basis. They generally contain a great deal of water so they can not be used for frying. Several such compounds have been developed from natural ingredients that are GRAS (Generally Recognized as Safe). Hence, the mimetics do not have to go through the same regulatory process and several are currently available commercially including:.

- **Simplesse-** a protein based fat replacer from Nutrasweet which is made from egg white or whey milk protein.
- **Oat Trim** - a cellulose based mimetic developed by the USDA and currently marketed to food companies by Rhone-Poulenc.
- **Avicel and Novagel** - both produced by FMC Corporation.
- **N-Oil** - a starch based mimetic from National Starch.
- **Stellar** - is made from corn starch and produced by A.E. Staley.
- **Slendid** - a natural food ingredient made out of pectin extracted from citrus peels by Hercules, Inc.
- **Salatrim** - a modified soy and canola oil based fat replacer developed by RJR Nabisco and marketed by Pfizer.

Several other similar type fats-sparing products have been developed by other companies in the U.S. and Europe. In terms of **fat substitutes, these are molecules whose physical and thermal properties resemble fat.** Theoretically, they can replace fat in all applications including frying. The true fat substitutes are not GRAS and hence, require FDA approval. To date, none have been approved by the FDA although several companies have developed fat substitutes and have been issued patents including:

Atlantic Richfield
CPC International
Curtis Bums
Dow Coming
Frito Lay
Proctor and Gambel
RJR Nabisco
Unilever

Even though the true fat substitutes offer technical advantages, its going to be **tough for companies to recover their investment** of millions of dollars that's required to gain regulatory approval and to commercialize these ingredients. Although the technology for developing fat replacers is progressing nicely, there is still a high amount of work to be done in optimizing the flavor and other organoleptic properties of low fat products.

Summary - Implications for Nutrient Databases

There are dynamic changes underway in the food system that have enormous implications for the future.

- The food industry continues to experience rapid change in terms of-
  mergers and acquisitions
  new product introductions
  nutrient and health claims for new products
  development of new ingredients and technologies that will add new complexities to new product introductions

- Consumers are changing their food attitudes and behavior usually in response to the media which headlines the often conflicting results from the latest "research study of the month".

- Government is continually changing the rules on what can and what cannot be said on food labels and in advertising.

These dynamic changes present several challenges to those involved in developing databases.

- There is a need to be flexible and nimble in being able to adapt and respond quickly to new technologies, ingredients and products; it is essential to employ state-of-the-art computer technology and electronic communications.

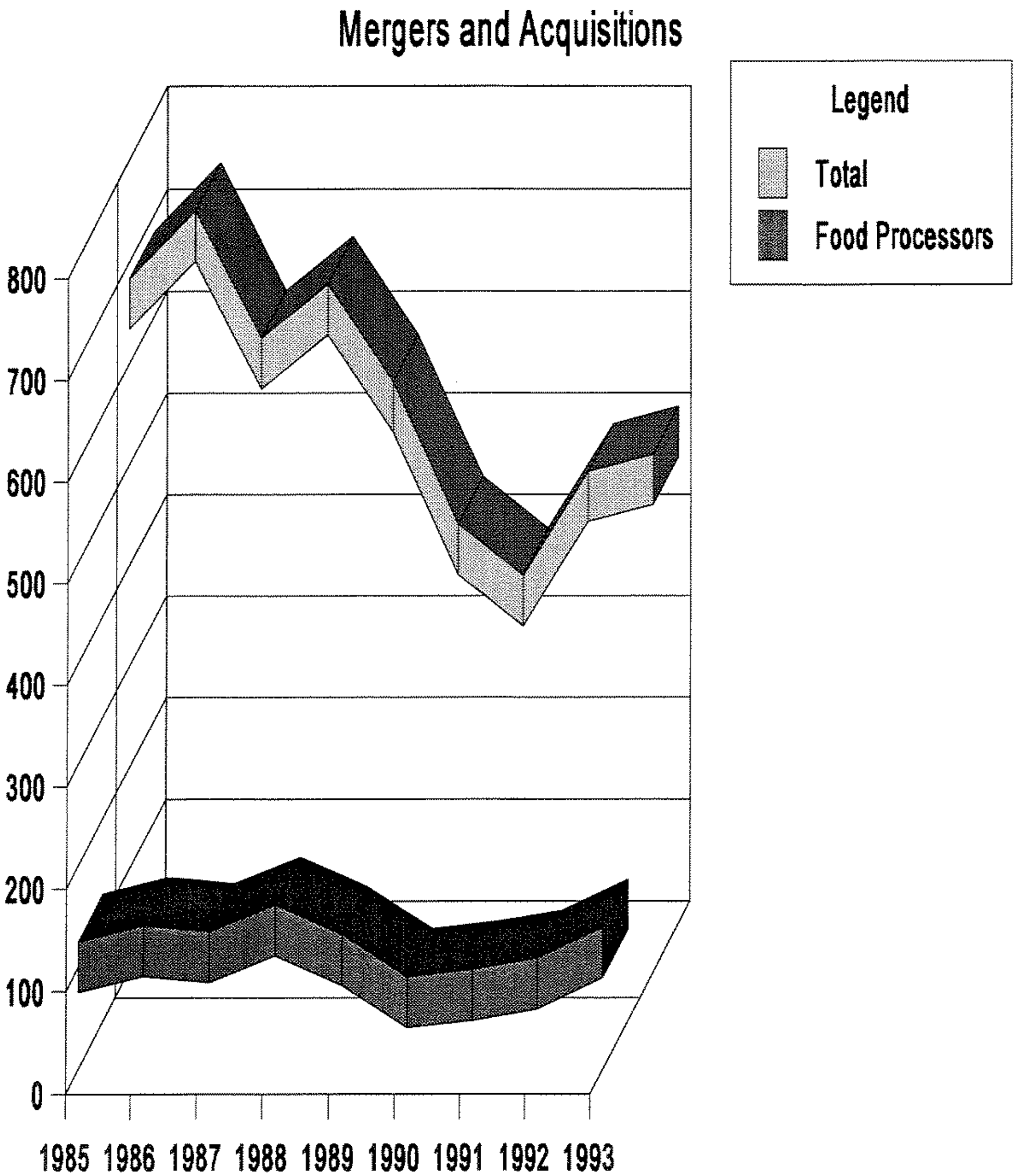
- There is a need to ensure that databases are complete, comprehensive and reflect adequately the composition of new ingredients and products. To obtain available compositional data, effective contacts need to be established with ingredient suppliers, food manufacturers and university and government laboratories.

- To assure integrity and quality of data,- a quality assurance and control component of database systems is essential.

Hopefully, these comments have helped to put into perspective the changes and complexity in the food system; they present major challenges to all involved in database development.

NOTE: Extensive reference material was used from New Product News (Trend Publishing), Prepared Foods (Cohner's Publishing Company) and Food Processing (Putnam Publications).

Figure 1: Food Business



From: The Food Institute

Figure 2

New Food Product Introductions

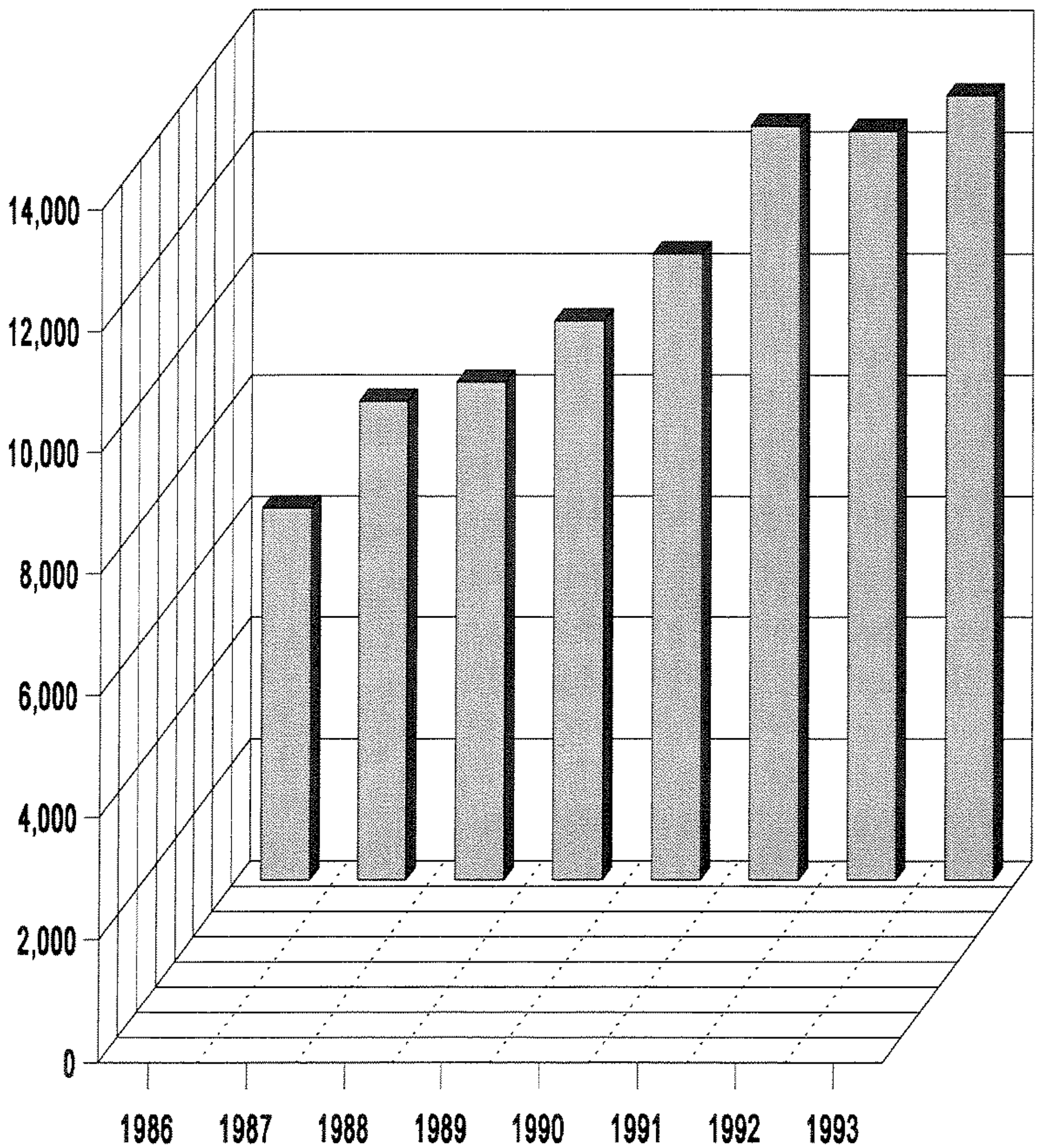
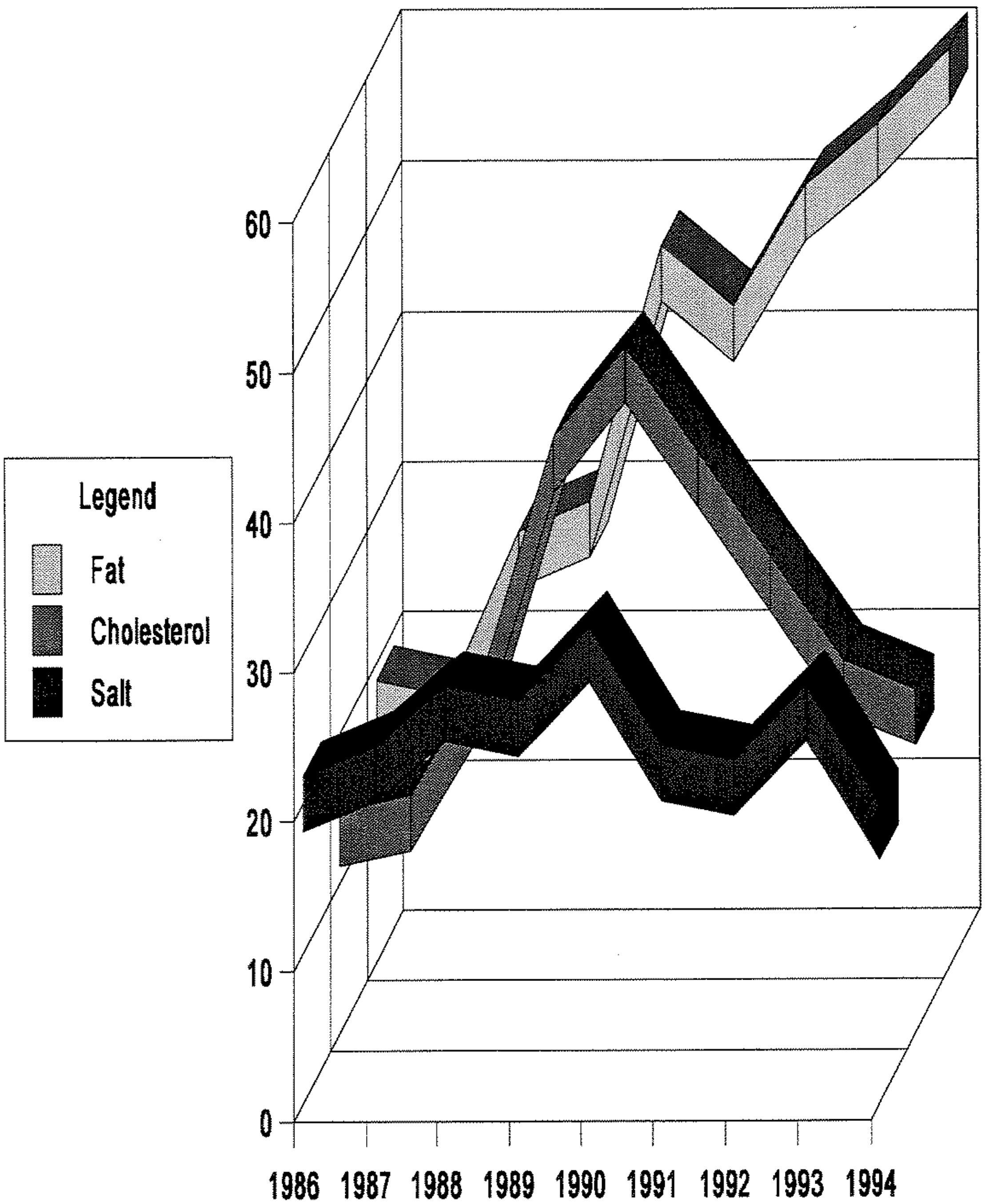


Figure 3: THE SURGEON GENERAL'S REPORT 1988
J.M. McGinnis and M. Nestle

CHANGE DIET --->	Reduce Fats	Control Calories	Increase Starch & Fiber	Reduce Sodium	Control Alcohol
REDUCE RISK					
Heart Disease	X	X		X	
Cancer	X	X	X		X
Stroke	X	X		X	X
Diabetes	X	X	X		
Gastrointestinal Diseases	X	X	X		X

Am. J. Clin. Nutr. 1989; 19:23-8

Figure 4: TRENDS IN CONSUMER'S CONCERNS ABOUT FAT, CHOLESTEROL AND SALT



From: Food Marketing Institute's "Trends 94"

Figure 5:

Products Bearing Health Claims

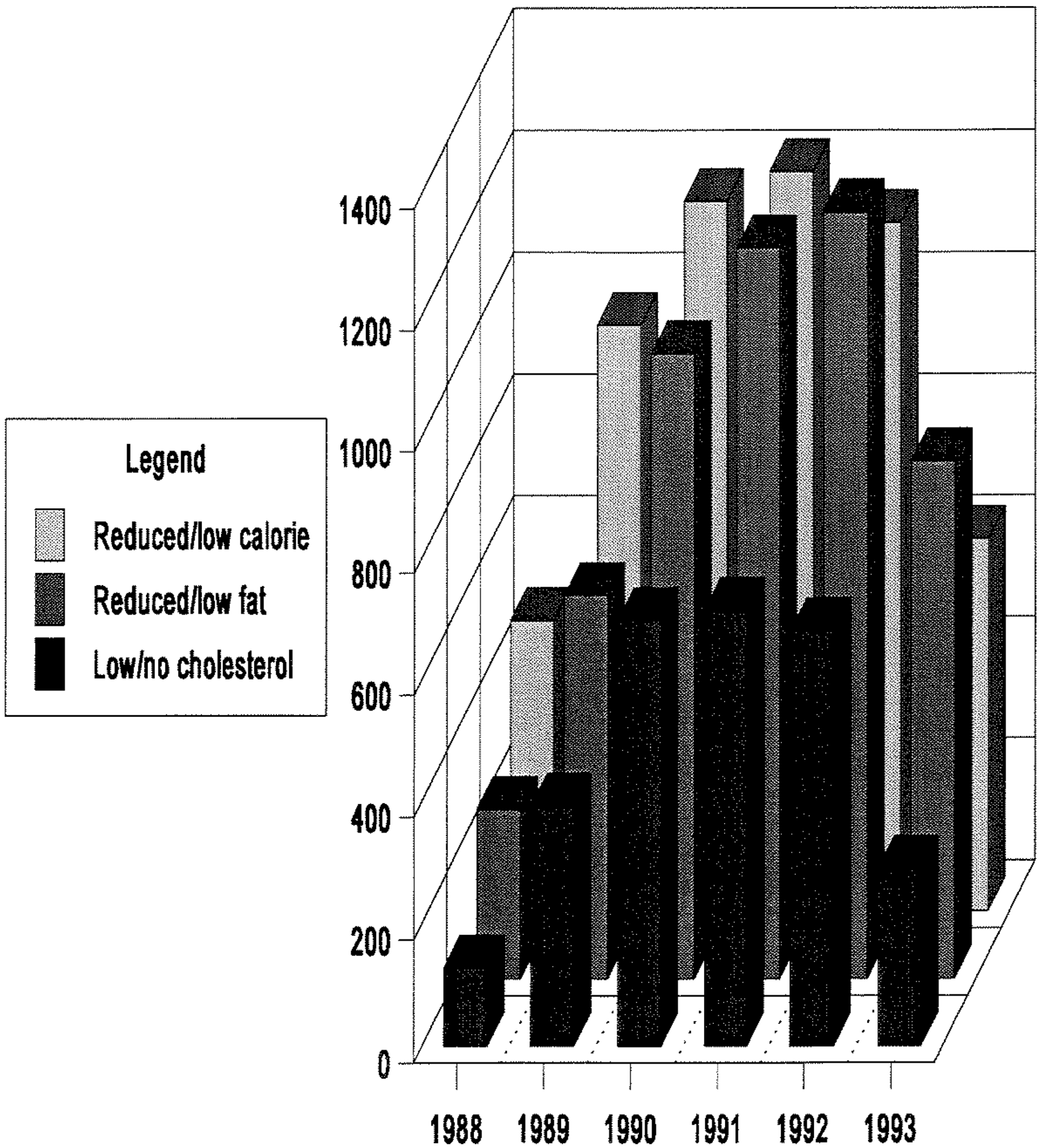


Figure 6

Products Bearing Health Claims

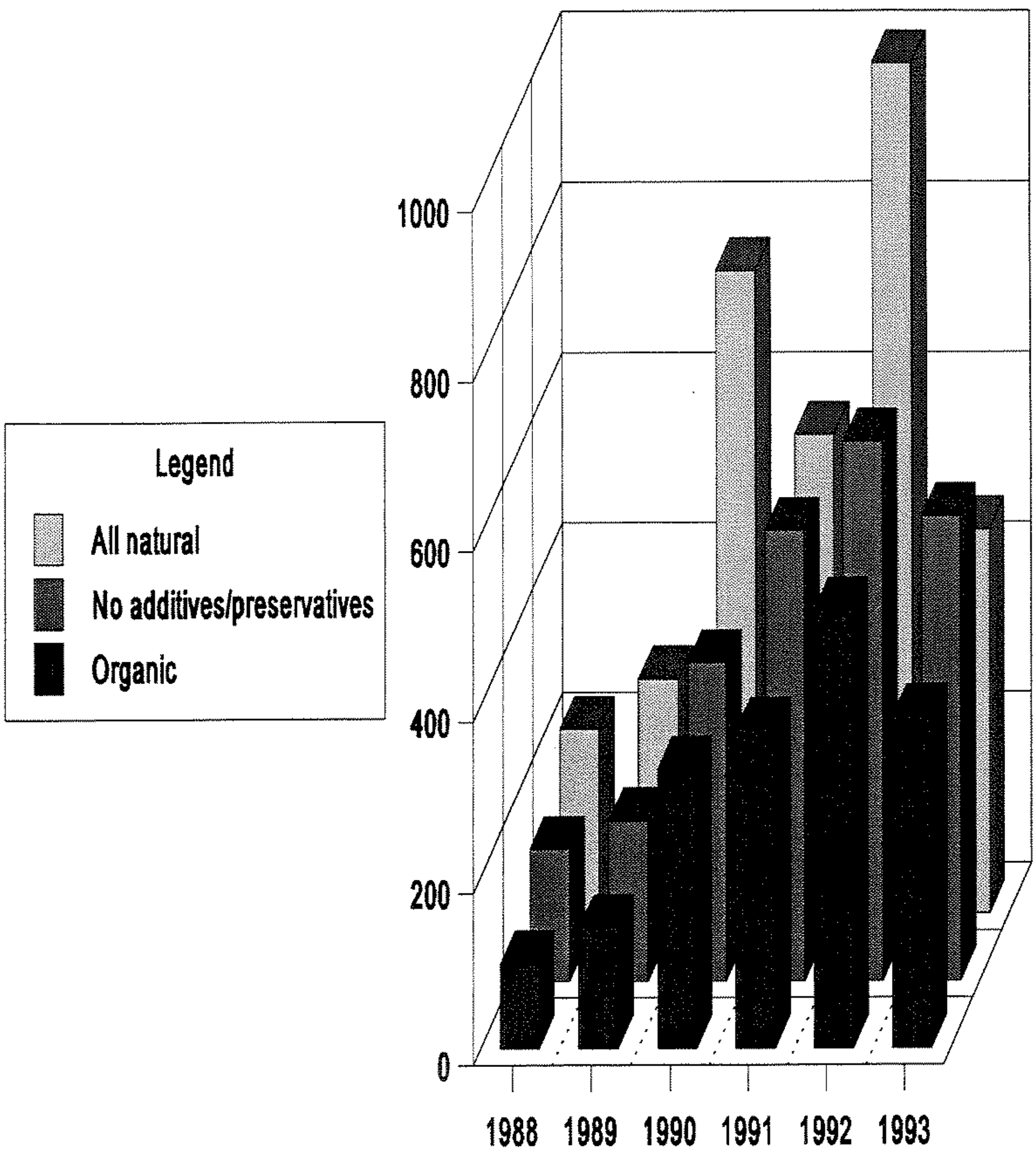


Figure 7

Products Bearing Health Claims

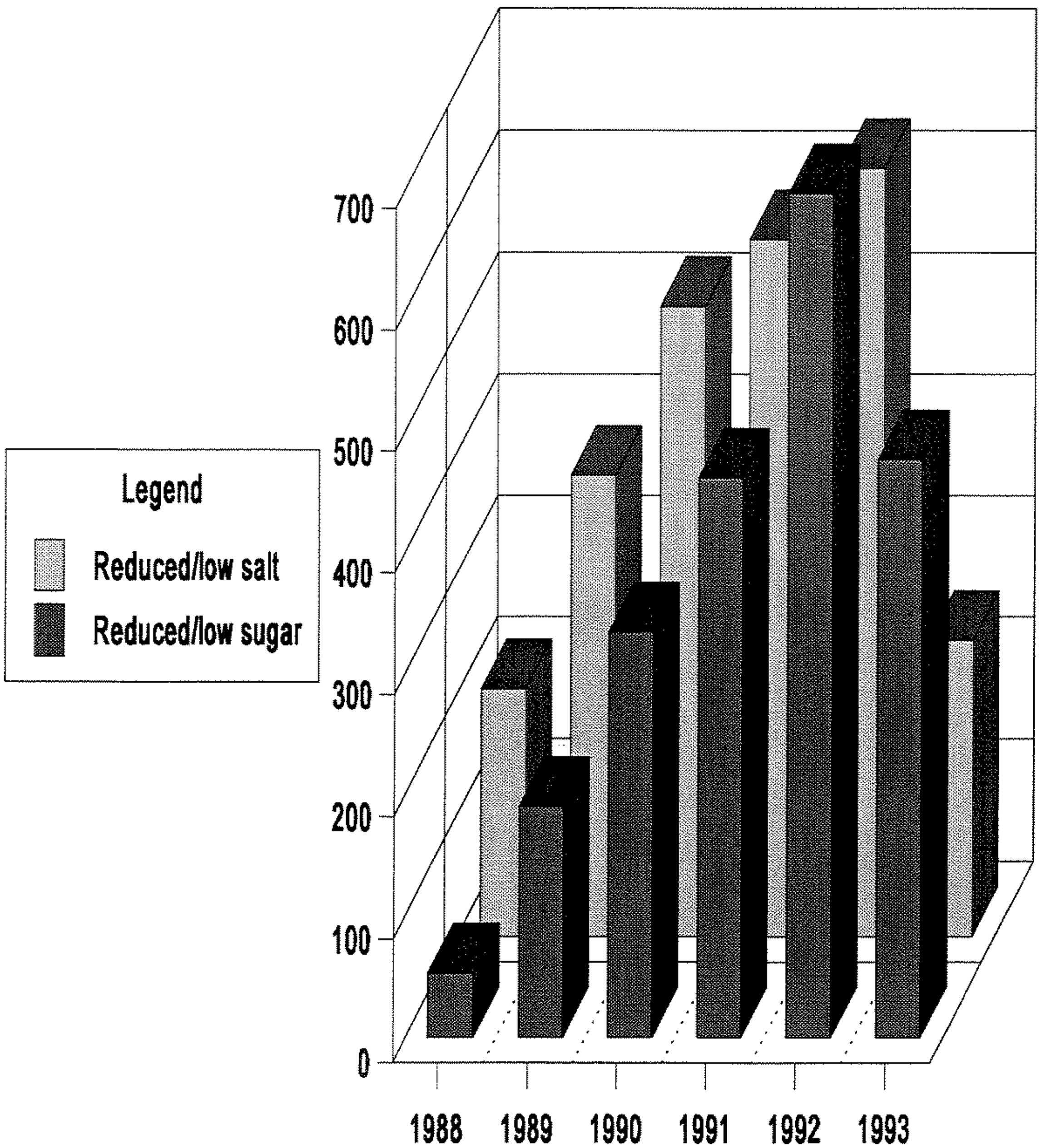


Figure 8

Products Bearing Health Claims

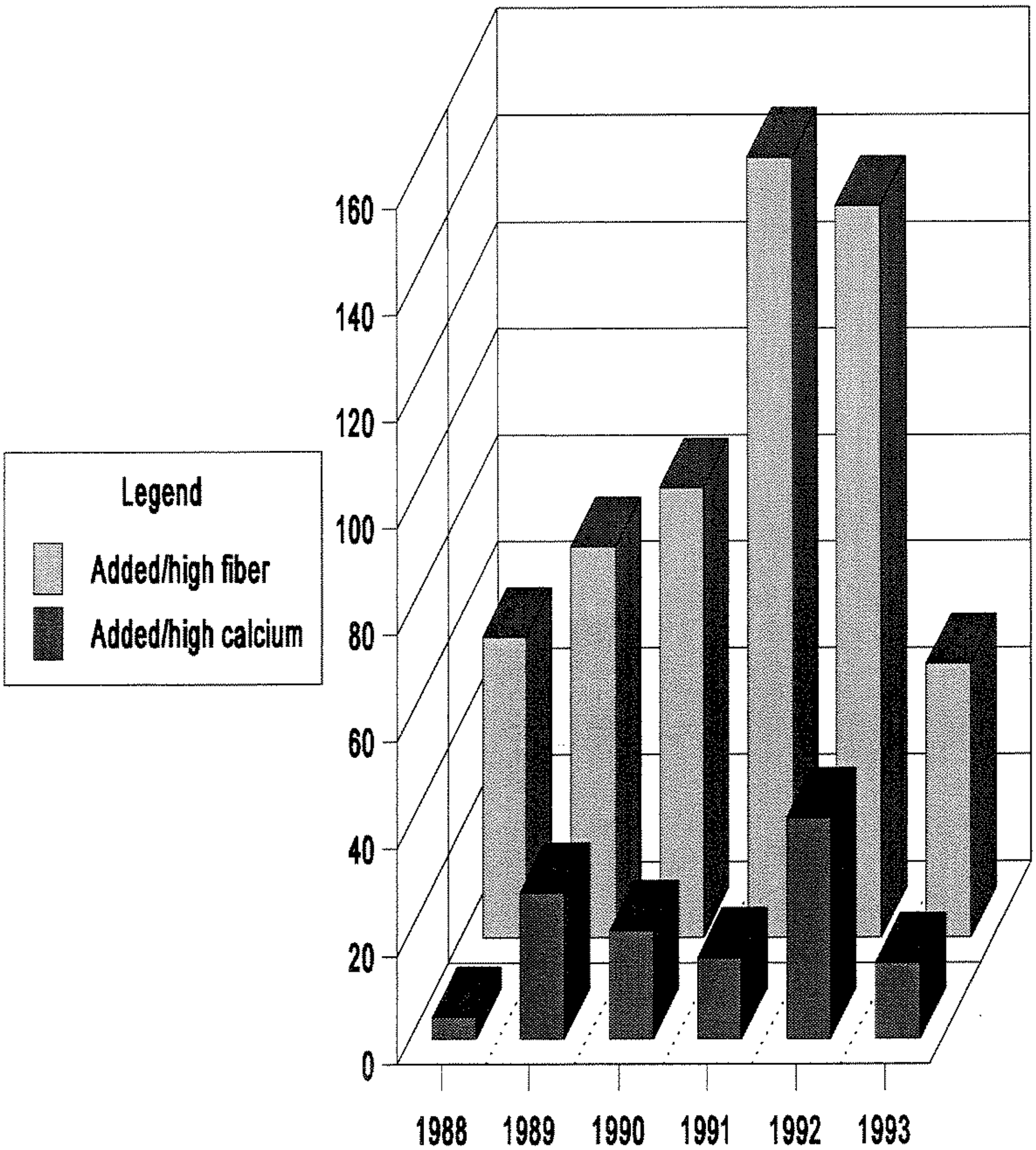


Table 1: SALES OF TOP U.S. FOOD PROCESSING FIRMS

COMPANY	Worldwide Food Sales ($ billion)
Philip Morris	33.0
ConAgra	21.2
Pepsico	13.7
Coca-Cola	13.0
Cargill	12.9
IBP	11.1
Anheuser-Busch	10.7
Mars, Inc.	9.2 (est.)
RJR Nabisco	6.7
Sara Lee	6.6
CPC International	6.6
H.J. Heinz	6.6
Campbell Soup	6.3
Kellogg	6.2
Quaker Oats	5.6
General Mills	5.2

Table 2: NEW PRODUCTS BY CATEGORIES

FOOD CATEGORIES	1987	1989	1991	1993
Baby Food	10	53	95	7
Bakery Products	931	1,155	1,631	1,420
Baking Ingredients	157	233	335	383
Beverages	832	913	1,367	1,845
Breakfast Cereal	92	118	108	99
Candy/Gum/Snacks	1,145	1,355	1,885	2,042
Condiments	1,367	1,701	2,787	3,148
Dairy	1,132	1,348	1,111	1,099
Desserts	56	69	124	158
Entrees	691	694	808	631
Fruits & Vegetables	185	214	356	407
Pet Food	82	126	202	276
Processed Meat	581	509	798	454
Side Dishes	435	489	530	680
Soup	170	215	265	248
TOTAL, FOOD	**1,766**	**9,192**	**12,398**	**12,897**

Table 3: NEW FOOD PRODUCT INTRODUCTIONS BY TOP 15 COMPANIES

	1993	1992
Nestle	186	114
Philip Morris	170	256
ConAgra	114	151
Campbell Soup	96	121
Wessanen USA	93	81
H.J. Heinz	91	99
Grand Met	88	74
RJR Nabisco	72	67
General Mills	70	61
Pet	70	11
Unilever	66	53
Hormel Foods	64	50
Pepsico	62	34
Sara Lee	62	60
Specialty Brands	48	33

Table 4: THE CHANGING AMERICAN DIET
% Change in Per Capita Consumption
1990 versus 1960

	%
Cholesterol	- 18
Low-fat Milk	+ 4,000
Whole Milk	- 62
Sugar	- 36
Eggs	- 26
Coffee	- 41
Chicken	+ 70
Pasta	+ 60
Fish	+ 53
Fresh Vegetables	+ 45
Fresh Fruits	+ 5
Red Meat	- 14
Cereals	+ 16

Table 5: TRENDS IN CONSUMER'S DIETARY BEHAVIOR

	1990 %	1992 %	1994 %
Any Dietary Change	90	93	94
More Fruits/Vegetables	57	60	63
Less Fats/Oils	27	28	32
Less Cholesterol	15	8	3
More Fish	18	10	8
More Fiber/Less Salt	16	8	7

FROM: Food Marketing Institute's "Trends 94"

Table 6: PRIVATE LABEL'S MARKET SHARES

	Category Share (%)
Milk	65
Frozen Vegetables	44
Butter	41
Cottage Cheese	40
Frozen Juices	32
Fresh Bread and Rolls	29
Ice Cream	28
Cheese	27
Cookies	11
Carbonated Beverages	8
Chips and Snacks	7
Coffee	6
Cold Cereal	6

FROM: Food Marketing Institutes "Trends 94"

Table 7: NEW PRODUCTS BEARING HEALTH CLAIMS INTRODUCED IN 1993

Reduced/low fat	847
Reduced/low calorie	609
Low/no cholesterol	287
No additives/preservatives	543
All natural	449
Organic	385
Reduced/low sugar	473
Reduced/low salt	242
Added/high fiber	51
Added/high calcium	14

How Trends Are Affecting Databases - Panel Discussion

Betty Perloff, USDA-ARS-HNIS

The U.S. Department of Agriculture (USDA) has developed and continually manages several data bases containing information about foods. This information covers food names; food descriptors; food formulations and recipes; the composition of foods; food yields; nutrient retentions for different types of foods; factors for deriving energy, protein, and fatty acid values of foods; and weights for various measures of foods.

Food data bases are accessed by various USDA systems, each of which, in turn, generates its own unique food-related data sets. For example, the National Nutrient Data Bank system uses all of the different types of food information listed above during its processing to produce reference data sets on the composition of foods. Another system, Survey Net, uses food names, descriptions, recipes, and food weights for coding dietary intake data from nationwide food surveys; links the intake data to food composition information; and produces data sets on the consumption of both foods and nutrients. A third system, the Food Grouping System, utilizes the data sets produced by the Nutrient Data Bank and Survey Net to report food and nutrient consumption data after the foods have been grouped by various food characteristics. The ingredients in mixtures are taken into account during the food grouping process.

Several factors affect the priorities and current direction of data base activities at HNIS. First, the shear numbers of foods and the increasing diversity of new foods are having a tremendous impact on the amount of resources needed for management of food data bases. Second, the need to process food consumption survey data quickly requires intensive efforts to obtain information about new foods in a very short period. Third, the need to respond to food safety concerns requires knowing not only the nutritional value of foods but also the specific ingredients and processing steps associated with foods.

In addition, all of these requirements must be balanced against the need to ensure that the data bases are as accurate as possible. In October of last year, the General Accounting Office issued recommendations for improving USDA's food composition data. While full implementation of their recommendations is desirable, the funding that would be required for additional food analyses by the government far exceeds the available budget. In the meantime, USDA must meet the demands for information about foods by carefully setting priorities for expending the limited public funds available for food analyses and by developing techniques to provide adequate estimates about the composition of foods that cannot be analyzed.

The data base most often affected by the numbers of new foods and the diversity of those foods is the food coding data base used within Survey Net. Foods reported by survey respondents in the Continuing Survey of Food Intakes by Individuals are matched against the foods in this data base, and foods reported in the National Health and Nutrition Examination Survey III (NHANES III) are also linked to the codes which represent the foods. Each year several thousand new foods enter the market. We hear about many of these foods for the first time when their names or descriptions are reported by respondents in the food consumption survey. When a new food is reported, staff immediately begin locating information about it, such as what ingredients are in it, what its composition is, and how much various portion sizes weigh.

The National Center for Health Statistics provides information about new foods appearing on NHANES III. This coding data base contains over 7,000 individual items with their own unique food codes, and over 5,000 additional food names or descriptions are linked to those codes. It also contains over 28,000 weights of portion sizes and common household measures associated with the foods in the data base.

One of the most time-consuming aspects of processing dietary intake data from nationwide food surveys is dealing with uncodable items, which are usually new foods or new combinations of existing foods. One of the main goals of developing Survey Net was to facilitate this aspect of processing survey data. Survey Net operates at both the survey contractor's site and at USDA. Coded intake records are sent electronically to USDA. In turn, updated food data bases (new food descriptions, weights, and recipes) are sent back to the contractor.

When a new item is encountered for the first time, it is written to a special file of uncodable items, where it automatically receives its own code number. Once a new food has been listed on this special file, it is available for retrieval and selection during the coding of subsequent food records. Each time an item is selected from this file, its unique code number is recorded on the intake record instead of a food code. The file of uncodable items is transmitted to HNIS along with the intake records, and the Survey Net team decides if each item needs a new code or if an existing code can be used.

Another feature of Survey Net is recipe modification. During food coding, the recipe for an existing food can be modified to record more specific information when supplied by the respondent. One of the main uses of this feature is to record the specific types of fat and milk used in recipes.

The recipe modification feature also facilitates collecting the detailed information needed for dealing with food safety concerns. For example, the Environmental Protection Agency needs better estimates of water consumption. Existing recipes for reconstituted items, such as infant formulas, can be modified when the dilution does not follow the package direction.

Because of the large numbers of new foods reported on the survey and because nutrient values are not available for all nutrients in all foods, considerable effort is required to estimate nutrient values, and HNIS has been focusing on automating more of its estimating procedures. Many values are derived through calculations using recipes and estimated formulations. Staff have discussed at previous Data Bank Conferences the technique for estimating formulations using ingredient lists and partial nutrient profiles. The Nutrient Data Research Branch has been writing other special computer programs to derive values based on existing data for similar foods by making adjustments in moisture, fat, or other specified components. These programs will also be used to assist in tracking the derivation of values. As part of the planning process for the redesign of the Nutrient Data Bank system, staff have developed an extensive set of data derivation codes that will be used for indicating the types of processes used to generate values.

We have also begun tracking some types of changes for items in the nutrient files used with our Survey Nutrient Data Base in Survey Net. When new values are inserted, we indicate if they represent data improvements or actual changes in foods. When real changes occur in foods, such as changes in fortification levels of nutrients in breakfast cereals, we retain the older values in the data base with the appropriate dates attached to the values.

In the near future we believe a great deal of our data base maintenance will be in response to changes taking place because of new labeling requirements. For example, new descriptors required for certain foods will require changes in the food coding data base, and new fortification levels expected for some breakfast cereals will affect the nutrient data base. For the longer range, we believe calculations of mixtures using formulations will continue to be an important part of our process. All of our calculation processes will eventually be formalized within the National Nutrient Data Bank system and codes indicating the types of calculation processes will be included with the final values. We are hopeful that recent attention focused on food composition data will result in more emphasis being given to better analytical methods, including methods that are less expensive, so that eventually the quantity and quality of food composition data that are truely needed can be realized.

How New Food Trends Are Affecting Industry Use of Databases

Chor San Khoo & Bonnie Sherr (Presenter), Campbell Soup Company

Thank you for the opportunity to address the 19th National Nutrient Databank Conference. I have been attending and enjoying these conferences for many years, and I want to express my appreciation to the organizers for this opportunity. I cannot substitute for Chor San. Those of you who know her realize that her knowledge and insights are far-reaching and unique. So bear with me while I try to do just that.

I have organized my brief comments as follows. First I will list what we see as being the major trends in the food industry, all of which have direct implications for database developers. Then I will discuss the consequences of the trends on our work environment, propose approaches which will provide solutions, and come to some conclusions.

The first major trend affecting industry use of databases is a trend toward healthier eating. Consumers are becoming more aware of what to look for on a label and this awareness is expected to continue to increase with the educational component of NLEA. Along with that comes the requirement on the industry to develop healthier foods. They want calorie-, fat- saturated fat-, cholesterol- and sodium-controlled products. They want products which provide the beneficial components they are hearing about in the media (such as antioxidant nutrients, folic acid, minerals and fiber). And they continue to want products low in sugar. We in the food industry must respond appropriately to consumer demand.

A second major trend is a supermarket shelf space war going on, the result of fierce competition for a limited amount of space in the stores. The product development time line, meanwhile, has been shrinking. What used to take 18 months has been reduced to 8 to 12 months time. In order to introduce a new product line, shelf space requirements demand at least 12 varieties be introduced. And these products must be an accurate result of the product development process. We can't afford to make mistakes. The resulting constraints are prohibitive, both from a time and cost perspective. And all the while we must work in an environment where R & D budgets are shrinking. The Food Industry generally spends 0.5 to 0.8% of its total sales dollars on R & D compared with about 11% for the Pharmaceutical Industry. So we need to work very efficiently, economically, and predictably.

Finally, the mandatory nutrition labeling which came into effect two weeks ago with NLEA is a third major trend with a direct effect on industry use of databases.

Just to give you an idea of how varied our uses of databases are, I have listed here the types of demands placed on our nutrient database (see Figure 1). The database is an essential resource in our Nutrition Science group. And at various times it has had to serve all these different purposes. The difficulties in maintaining a database that must serve all these purposes is enormous. Some may say that we are asking too much of our nutrient database. But nonetheless, these are the functions it fulfills.

We need to build nutrient databases sufficiently accurate for labeling so that we can shorten the time to label. A complete laboratory analysis of all NLEA nutrients can take as much as 4 to 6 weeks. We must reduce the turnaround time from initial concept to label. Nutrient Database for Standard Reference (Handbook 8) updates are not frequent or ingredient specific enough to meet new product and product reformulation needs. Our shrinking R & D budget requires cost effectiveness to become a top priority in all our work. Many new products have short life spans. Our goal is to contribute toward the development of products which accurately fill the needs they were intended for.

We need databases accurate enough to meet regulatory compliance requirements. To date, we have not encountered such an "intelligent" database. Our database should take into account the effect of processing on nutrient composition. We need better ingredient data. For some ingredients, these must be company specific: for example, our unique spice mixes and flavors. For other ingredients, we need more generic USDA ingredient-based data. Such a database will accurately predict label values during the development phase and ultimately can be used to label products. For dietary assessment, menu planning, therapeutic dietary guidance and recipe development, we need more brand-specific data in Handbook 8. The current soup values in Handbook 8-6, for example, are Campbell products from 1980, and thus do not reflect many products currently in the marketplace. Industry has an obvious role to play in improving brand-specific data.

On the subject of industry-supplied data to Handbook 8, what is a reasonable request of industry? In this era of reduced R & D budgets, we must weigh carefully how we are going to spend our scarce resources. With reference to the quality assurance measures that the October 1993 GAO report considered essential for determining the scientific validity of food composition data, we need to be willing to supply information on the selection and treatment of samples as well as the number of samples to assure confidence in our data. Some agreement must be reached between the data suppliers (food industry) and data distributors (USDA) on the frequency with which requests can be processed. Imputation of missing nutrients (non-label nutrients) is a complex issue, involving protection of company interests, time constraints and legal issues. These issues must be addressed.

We in the food industry need to know how the data we supply will be made available to the public. Will it be updated as received, on a yearly basis, or by some other schedule? We need to be told how the data will be handled; that is, will product data be averaged with other suppliers of similar products, or will data be presented by brand? And finally, we need assurances that trademarks will be respected.

The result of careful and precise database development will benefit consumers as well as government agencies and industry by assuring the accuracy of the information on the product label. Better data will be available for software developers. And more accurate information on branded products will be included in USDA databases at low cost to the public. We look forward to working together with all of these groups to continue to improve the quality of nutrient databases.

Food Industry Nutrient Databases are Used for Many Purposes

- ✓ Product Development
- ✓ Menu Planning
- ✓ Recipe Development
- ✓ Dietary Assessment
- ✓ Therapeutic Diets
- ✓ Clinical Studies
- ✓ Advertising Substantiation
- ✓ Competitor Comparisons
- ✓ Eating Pattern Analysis
- ✓ Research

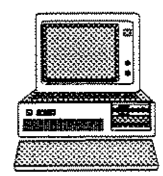


Figure 1

How New Food Trends Are Affecting Industry Use of Databases

Chor San Khoo, Ph. D
Bonnie Sherr, MSE, MS, RD

Campbell Soup Company

19th National Nutrient Databank Conference
St. Louis, Missouri
May 22-24, 1994

Trends in Foods

Healthier Eating ===> Healthier Foods
Supermarket Shelf Space War ===> Fierce Competition
Mandatory Labeling (NLEA)

Food Industry Nutrient Databases are Used for Many Purposes

- ✓Product Development
- ✓Menu Planning
- ✓Recipe Development
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- ✓Therapeutic Diets
- ✓Clinical Studies
- ✓Advertising Substantiation
- ✓Competitor Comparisons
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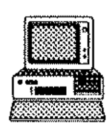
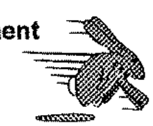


Consequences of Trends on Food/Nutrition Databases

Build Nutrient Databases Sufficiently Accurate for Labeling

Shorten Time to Label
- Reduce Turnaround Time
- USDA Handbook 8 Updates not Frequent Enough to Meet New Product / Product Reformulation Needs

Cost Effectiveness
- Shrinking R & D Budget
- Short Turnaround Time for Product Development
- Accuracy



Solutions

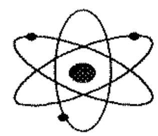
Develop Better "Intelligent" Databases to Calculate Nutrient Values for Products

Must Know Effect of Processing on Nutrient Composition

Better Ingredient Data
- Company Specific
- More Generic Ingredient Data

Goal is to Use Databases:
- During Development To Predict Label Values
- Ultimately To Use for Labels

More Brand Specific Data in Handbook 8



Solutions

Shorten Time Line - Industry-Supplied Data

What is a Reasonable Request ?
- Number of Samples
- Laboratory Methods/Standards
- Frequency of Requests
- Imputation of Missing Nutrients

Schedule for Inclusion

Knowledge of Data Handling Techniques

Assurances that Trademarks will be Respected

Conclusions

Benefit for Consumers, Government Agencies, Industry
- Accurate Information on Final Product

Better Data for Software Developers

Accurate Data on Branded Products

USDA Access to Nutrient Data at Low Cost
- More Data Available for Handbook 8

How Trends Are Affecting Databases - Panel Discussion

Meeting the Challenge of the Changing Food Marketplace: The MDRD Study Experience, Monica E. Yamamoto, Fran L. Jones, Rebecca J. Meehan, Meribeth E. Riccio, Charlene A. Walter and the MDRD Study. University of Pittsburgh

Dietary assessments are professionally challenging. But if you add--dietary intervention, 15-collaborating sites, multiple years and ethnic and regional diversity, dietary assessments become an amazingly, exciting adventure. It's exciting because of the enormous pressures and complexities of the work and an adventure since this is largely uncharted territory.

The Modification of Diet in Renal Disease (MDRD) Study offered all of these challenges. This 15-center intervention study, sponsored by NIH-NIDDK and HICFA, examined whether diet and/or blood pressure interventions could slow the progression of renal disease in patients with mildly to moderately reduced renal function. Three levels of protein and phosphorus were tested: a protein level that approximated that of the US population, a level which was about half that amount which was approximately the level of the World Health Organization (WHO) recommendations and a lower level which was about half the WHO level for food protein but was supplemented to the WHO level with an amino- and keto-acid mixture. Two blood pressure levels were tested: one of which was the level of the usual standard of care and another level which was lower than that. A total of 840 patients were randomized to the study and followed for an average of 2.2 years (18 to 45 months) during the period of January 1989 to June 1993. Fifteen clinical centers participated in this Study and these included "Mega-urban" areas (New York City, Boston, Washington, DC and Los Angeles); Southern areas (Tennessee, North Carolina which had 2 centers and Georgia); Midwestern areas (Ohio and Iowa) and areas with large Hispanic populations (Miami, Texas and East Los Angeles). There were four central facilities including a MDRD Nutrition Coordinating Center (MDRD-NCC) located in Pittsburgh. I had the privilege of directing the MDRD-NCC's Dietary Data Center whose work is being discussed in this presentation.

Dietary assessments were done bimonthly and nutrient summary reports from these were provided to patients regularly throughout the study. Our challenge in providing nutrient intake estimates was to ensure that unbiased research quality information was available to the study while supporting the work of our intervention colleagues. Our research requirements were to provide estimates of protein, phosphorus and calorie intakes that were precise, that were consistent and reliable regardless of any change that might happen during the study. This included Dietary Data Center staff changes; staff changes at clinical centers as well as changes in the food marketplace. We were asked to meet a 10 percent precision level on those nutrients. This meant that a 55 kg women on the lowest protein prescription could have no more than a 0.5 gram error in protein per meal. Being blinded to the diet prescription assignment, all dietary data needed to be coded as carefully as possible. To meet compliance goals patients needed to be in compliance range by the Study's urinary protein compliance measure.

The MDRD nutrition intervention program was called "Protein Wise". To support intervention patients received feedback [nutrient summary reports] on their 3-day food records. Food composition information was provided for counseling. A prominent feature of this intervention was its ability to support "flexible" dietary pattern modifications. Patients were encouraged to try new foods as well as to modify their usual foods. Food records included "home" modifications of standard and personal favorite food items including ethnic foods, local/regional specialties, convenience food items, low protein food products, market modified food items. The intervention also sought to support "quality of life" strategies: eating out, celebrating with friends, holidays & family occasions, business meetings, travel, etc. This included eating at favorite restaurants, local fast foods. This intervention was very successful. Patients showed outstanding long-term adherence to the three distinct protein goals. In fact, 60 to 80% of patients were in adherence range by biochemical measures over the entire period of follow-up.

Our strategy and planning for our work with MDRD Study dietary assessments included several levels of activities. We met with nutrition professionals who had participated in the MDRD Feasibility Study (MDRD Phase II) and who were slated to participate in the full trial (MDRD Phase III) and solicited suggestions and recommendations from them. A "problem item" tracking system was developed (reported at the 1989 National Nutrient Databank meetings in Framingham) and implemented which allowed flexibility in foods coding while maintaining important quality control standardization. Finally, we relied on "networking" among professionals doing similar types of work and this yearly National Nutrient Databank meeting was very important to this effort.

Over the five years of the Full Trial (1989-1993) the MDRD-NCC's Dietary Data Center coded and processed 41,093 days of data. Patient reported recipes totaled 13,562 and nearly one million foods were coded and processed. For this report we examined food trends through our tracking system for "problem food" items. These are reported foods for which specific food composition data were unavailable at the time the data was initially coded. "Problem food" items totaled 3,324. The average number of "problem foods" per record declined from a high of 0.8 (1989) to a low of less than 0.2 (1992) with a slight rise (to 0.3) in the Study's final year (1993). The majority of "problem foods" were regular foods;, about 23% were new "modified" products, i.e. modified in total calories, fat, sodium, etc.; and less than 1% were foods which were specifically designed for therapeutic diets. "Problem" regular foods were from a variety of food types but the largest proportion were grains (36%) followed by meats (17%), fruits and vegetables (11%) and fats, oils, soups and sauces (11%). The vast majority (79%) of the "problem" grains were bakery products but included snack items (13%) and breakfast cereals (8%). Grains also constituted the largest proportion (37%) of "problems" for modified foods. The next largest groupings were fats, oils, soups and sauces (15%), dairy foods (12%) and fruits and vegetables (11%). Similar types of "problem" grains occurred for modified foods although the relative rankings of these were different: bakery (57%), breakfast cereals (29%) and snack items (14%). Grains modified for fiber content were the largest group (55%) followed by reduced calorie (16%), reduced fat (15%) and reduced salt (13%). "Problem" modified dairy products were likely to be reduced fat (52%) or reduced calorie (40%) although a few reported items were modified for protein, calcium or sodium. MDRD Study trends in reported fat modified items appeared to follow the market release timings reported by the previous speaker.

We also examined trends in reported recipes and ethnic foods usage. MDRD Study patients from Southern centers were more likely to report recipes (about 40% of total recipes) and patients from the Hispanic centers were least (less than 15%) likely. As expected higher usage of ethnic items and ethnic recipes was seen in MDRD Study Mega-urban areas and Hispanic foods in Hispanic areas. However, even Southern and Midwestern areas reported some usage. As expected, pasta and pasta recipes, which are very time efficient to prepare, were popular in Mega-urban areas. Regular pasta was generally popular and low-protein pastas were popular for patients on very low protein diets from Southern and Midwestern centers.

CONCLUSION:

MDRD food choice trends reflect marketplace changes: changes in home cooking (as estimated from reported recipes) and ethnic food consumption even in Southern areas and the Midwest states. Mega-urban areas, as expected, showed a preference for a variety of ethnic foods but had less home cooking except for quickly prepared items such as pastas and "Asian" foods. Even though patients with a chronic disease might be expected to resist exploring new foods usage, MDRD patients showed similar food trends as did Americans as a whole (as reported earlier today by Dr. Bruce Stillings). Given our MDRD Study experience we'd strongly advise other nutrition research studies to expect foods marketplace changes and changes in their participants' food choices as well. To end my presentation, I would suggest that if we, nutritional professionals, are truly successful in supporting our clients change towards healthier eating behaviors, we will ensure their fully enjoying our Changing Food Marketplace.

TRENDS IN COMPUTER TECHNOLOGY

Trends in Computer Technology

Bill Plummer, University of Missouri-Columbia

The computer revolution is one of the certifiable success stories of recent times. As a commercial venture it has succeeded wildly, spawning Fortune 500 companies worth hundreds of billions in aggregate. In technical terms it has had an unparalleled record of price/performance improvements. It is even environmentally clean, although among the truly addicted, it produces a sedentary life style that must be regarded as fattening!

One may use the amazing performance improvements to construct analogies with more common enterprises. For instance, if the automobile industry had kept pace over the last 15 years, the Rolls-Royce would cost $1000 and would get 1000 miles per gallon. Of course, in fairness one must note that it would also be the size of a tricycle.

This record of improvement is due to progress in three spheres of activity: the means of construction of the basic electronic building blocks (the "chips"); the means of assembling the basic elements (computer design and engineering); and the means of controlling this hardware (programming and computer science). We will deal briefly with each of these realms, to see where the growth curve appears to be headed. However, the most significant point to be addressed is more in the realm of psychology: how will the increasing power of technology line up with the expectations of the user community?

Hardware

The breakthrough technological advance of the last decade has been the integrated circuit of complementary metal-oxide-silicon (CMOS) construction. This technique has led to the miniaturization, the energy saving, and the cost improvements which we now enjoy. The steady improvements in performance-- speed of operation, number of transistors per chip, etc. -- has depended mainly on manufacturing technique. The basic physics and chemistry have remained the same for a considerable period.

These chips are based on a wafer of silicon which has been doped with a metal oxide, resulting in the type of material known as a semiconductor. Depending on the dopant, the semiconductor is one of two types, p or n, according to whether it has positive or negative carriers of charge. Channels can then be etched in this wafer by lithographic techniques employing electron beams, light, or in the near future x-rays. When channels are etched and alternating p, insulating, and n layers are formed, groupings of features can be made to form a field-effect transistor. The transistor is the basic element from which the computer circuitry is constructed, and the etching process determines the electrical nature of the circuit. The channels and semiconducting layers are equivalent to all of the tubes and wires found in larger devices.

The complexity of the electronics is determined by the number of transistors that can be placed on the chip and this is critically influenced by the size of the features that can be etched. Presently available computers at my university have feature sizes of 0.5 microns (a micron, is one-millionth of a meter.) This compares with sizes of 2.5 microns in 1980, 25 microns in 1960, and 100 microns for the human hair. Since the device can be two or three centimeters in size (if too large then the opportunity for defects becomes excessive) it is now possible to have several million components on a single chip.

As the features get smaller and closer together, several good things happen for the circuit designer. The speed of switching goes up, and the energy required to achieve a given switching speed goes down. This is reflected in clock rates often quoted by vendors, and we can roughly track progress in manufacture as speeds go from 25 MHz to 50 MHz and up. If the energy need did not go down then the chip would fail, either because of excessive heat or because of the electric fields that provide the energy would be dense enough to disrupt the semiconductor. These factors help permit the greater number of elements per chip, which is essential for addressing the "down" side of miniaturization: interconnecting discrete elements becomes both an electrical and a mechanical nightmare. Fewer complex chips means fewer discrete connections to contend with.

There are theoretical limits to how small the feature size can become, and these limits suggest that a reduction to one-third of present dimensions is all that may be expected for CMOS. As a practical matter, one-half of the present size may be more realistic. This will surely occur by the end of the century, at which point the most fundamental driving force for improvement will have leveled off. The exponential phase is rather quickly coming to an end.

There are some caveats to be noted. The above estimates are for CMOS only, and do not necessarily apply to other materials that might be used or to other physical effects that might be used to develop circuitry. After all, CMOS was preceded by other technologies (bipolar, etc.) which were supplanted just as they were running out of steam. A leading contender to outstrip silicon-based technology has long been considered to be gallium arsenide. While this material is in use in communications gear and in at least one commercially available computer, it appears that it will increase performance only by a further factor of about two. More speculative schemes based on quantum effects, light, or superconductors seem to be some decades away, but pessimistic predictions in this field have usually returned to haunt the prognosticator.

Architecture

The way that the transistors are put together into computing components--memory, arithmetic units, etc.-- and the way that these larger functional units are assembled into complete systems have a major effect on the performance of computers. At the component level, one should think about not only the speed of the unit, which can be measured by the clock rate, but about what work is accomplished in each clock cycle. As might be imagined, there is a huge variation in this regard among various devices currently in use. Historically, mainframe computers have a more powerful array of instructions than the PC, and, for a given clock rate have required fewer cycles and hence less time to accomplish some meaningful unit of work such as multiplying two numbers or sorting a data file.

The most significant recent development in computer design at the chip level is in the so-called "reduced instruction set computer", or RISC technology. Traditional computers, even microprocessors, often have a set of several hundred basic instructions which they can execute. Somewhat counter-intuitively, the RISC philosophy focuses on providing a much smaller number of the most used instructions. This focus permits these instructions to be extremely well-designed from the point of view of efficiency. But the real "secret" is that each of these key instructions can execute in the same number of cycles (the ultimate objective being one cycle). The pay-off derives from the fact that any complex task being performed by the computer will be limited by the slowest of the instructions that must be invoked. So a few weak instructions-- an almost inevitable consequence of a complex instruction set-- reduces the overall effectiveness of the calculation unless the programmer makes a very detailed study of the lowest level behavior of the system. This time consuming task is obviated if there simply are not any such bottlenecks to be avoided.

RISC architectures have, for several years, been the basis of all of the powerful workstations that are used for computationally demanding tasks such as scientific calculation, engineering design, or special effects in movies such as *Terminator-2.* In 1994 such chips have reached the mass market with the introduction the Apples "PowerMac" line of computers based on the "PowerPC" chip developed jointly by Apple, IBM, and Motorola. The personal computer will thus continue to improve in performance considerably more than the basic CMOS technology would support as they catch up in architectural features.

The other major trend is to found at the system-level of design, and this is the thrust toward computer systems that contain multiple central processing units. The idea is no more complicated than the notion that "many hands make light work". The traditional computer has one processor that sequentially executes instructions that eventually accomplish some unit of useful work. If the tasks can be spread out over several processors all working concurrently, then the job will be done faster even if the individual processors are no faster. Machines have been built with several hundred processors, and designs exist that are scalable to the range of 65,000 processors. When improvements in chips appear to be limited to a ten-fold increase, the attractiveness of "massively parallel processor" (MPP) architectures is obvious.

However, there are numerous difficulties with this superficial picture, and there is another handy aphorism to explain them: "too many cooks spoil the broth!" Many tasks are intrinsically sequential in nature, such as writing a sentence. It would not be effective to have a team of ten writers and assign each one to write every tenth word. Nor would most paragraphs benefit by assigning each writer every tenth sentence. Cooperative writing is practiced, of course, by dividing the task into larger blocks, each of which has some degree of logical completeness and, consequently, some degree of independence from the other blocks.

While the quality of the content may be improved, very few would claim that the writing task is simplified in a multi-author document or committee report. The optimum case is when the document can be structured in advance, different sections delegated to different people, and finally the whole edited and integrated. The preplanning and post writing tasks represent a degree of overhead that is intrinsic to the "parallelizing" of the writing task. And the situation may be very far from optimum: writers of the different sections may require intensive communication throughout the process to make sure that consistent terminology is used, definitions are introduced appropriately, and that the inevitable ambiguities in the outline are resolved. It is the communications overhead that is the critical issue for the success of most parallel applications, and this is significantly impacted by the initial strategy for partitioning the problem among the processors. A final pitfall that might be noted is that the job is not complete until the slowest of the writers finishes (a problem well understood by the editors of conference proceedings.!) so that the potential gains are lost if the units of work can not be completed in equal times.

While the detailed hardware design in parallel computers can partly mitigate some of these problems, there is little hope from this quarter for general purpose machines. The design that works best for one class of problems is frequently abysmal for other cases because of the inherent characteristics of the problems. It appears that the parallel environment will place greater responsibility on programmers, and the best hope appears to depend on developments in the area of software construction.

Software

The importance of computers derives from the universality of their application, and this derives from their programmability. The subway moves people within narrow constraints. The automobile is much more programmable with respect to routes and times. Still, it cannot be changed by a mouse-click into an airplane or an ocean liner; there is no universal transportation device. Consideration of algorithms, data structures, and programming matters moves us from materials science and computer engineering into the realm of computer science.

It is perhaps not generally known that advances in software have accounted for performance improvements of the same order of magnitude as those produced by hardware. The impact of the choice of algorithm, or the strategy for organizing the work, can be illustrated by some simple examples.

Consider a system of equations, which has the matrix form

$$Ax=b.$$

A straightforward solution would be to find the inverse of A, denoted A^{-1}, in terms of which the solution is

$$x=A^{-1}b.$$

For the same amount of work by the computer as it takes to find A^{-1} it is also possible to factor A into two simpler matrices, denoted L and U, which have the following structure: L is all zeros above the diagonal, and U is all zeros below. Using this factorization, A=LU, the original problem is equivalent to the two equations:

$$Ly=b \text{ and}$$
$$Ux=y$$

where y has been introduced as an intermediate construct. This hardly looks like progress; one equation has become two, and the new quantity y has been introduced.

However, assuming that there are n equations, the effort to compute x from A^{-1} is proportional to n^2. Because of the structure of L an U the effort in the second formulation is proportional to n for each of x and y. If n=1000, the effort by factorization is of the order of 2000, while using the inverse makes it of order 1,000,000! This saving is similar to decades of chip development, and is not yet reachable with available MPP machines. It follows from the observation that getting A=LU is better than getting A^{-1} because the ensuing calculation is linear with n rather than quadratic.

In several other important applications it has been found possible to reduce the number of operations required for the solution from n^2 to n log n. While not terribly significant for small n, this difference is quite noticeable if n=1000.

One of the major successes of theoretical computer science has been to extract the essence of broad classes of problems and obtain a lower bound on the number of calculations required *regardless of the particular algorithm employed.* Thus if the "best" that is allowed theoretically is n log n, and an algorithm is in hand that achieves this, then there is no need to look further. Conversely, if the best known method is of order n^2 then further study is justified.

This area of investigation, called computational complexity theory, has spurred major improvements in technique, but it has also produced some unpleasant shocks. Some problems (fortunately rather abstruse) are demonstrably insoluble; other problems (unfortunately rather simple-seeming) are solvable but grow exponentially in complexity as a function of some key parameter n. Identification of intractable problems is an important aspect of understanding the limits of computing capability that will exist even in the face of the stunning successes of hardware and software evolution.

Limits of Functionality

We have noted an exponential growth in computer capability, which is beginning to taper off. Limits are discernable unless MPP comes through or entirely new materials are developed. We have also noted that larger problems may quickly overwhelm capacity, and that only in some cases can this be overcome by clever programming. When "better" is equivalent to "bigger" there may be real limits to the improvement of functionality.

There is another non-linear agency at work when questions of benefits of computing are addressed, namely the psychology of the human mind. One need only look at the State Lottery to see that the perceived value of a ticket (the potential for riches) greatly exceeds its economic value (based on cost versus the probability of pay-off). And one need only visit a discount store to see that many will choose a cheaper alternative, even if there is a disproportionate sacrifice in performance (e.g. durablilty).

Word processing and spread sheets are often given credit for fueling the microcomputer revolution. Without such highly useful applications, the growth of computer power would be pointless, but these applications did not have their paradigm-shifting impact until the computer technology was adequate to the task. Considerable competence was clearly there by 1980, enough so to change society forever.

But despite this impact these applications have continued to evolve. Memory and disk requirements have increased a hundred-fold, and the processor requirements have increased almost as much. Subjectively, has the benefit increased by a factor of 100? A (very!) unscientific sample suggests the perceived increase in value is more nearly 2 than 10^2, suggesting a more nearly exponential than linear increase in value. Computer improvement has permitted this increase in complexity to occur with no increase in cost, and indeed the addition of features is probably significantly driven by a spirit of "how much can we get on the new box." Regardless of the numerical accuracy of this appraisal, the conclusion is inescapable that utility does not rise at the same exciting pace that computer capacity does.

There are some evidences of logistic curves in the psychological dimension. For example, a reduction from 10 seconds to 1 second to recalculate a spread sheet is probably significant to most users. Improving from 1 second to 1/10 th of a second is discernable, but not very important. An improvement from 1/10th to 1/100th is not even discernable.

Some interesting insights into the computational cost of benefits are provided by efforts at computer programs that play chess. Apart from the interest provided by complexity of chess as an intellectual activity, there is also a well-established numerical scale associated with chess-playing ability: the U.S. Chess Federation Rating System. This system is based on comparative results in sanctioned tournaments. The central idea is that a player gains points by winning or by drawing a game against a higher ranked opponent, and loses points by losing or drawing against a lower ranked player. By obtaining a high enough rating, a player also receives such designations as expert, master, or grandmaster. One or two computer programs have reached the grandmaster level, and freeware available on the internet can turn a desktop machine into an above-average tournament player.

The chess programs start by examining the available moves and choosing one based on certain rules provided by the program's author. For example, giving checkmate would always be played if possible.

At this point, the program is said to have examined one half-move or one "ply". This level does not produce good chess. It is much better if, for each of its possible moves, it examines the possible responses by its opponent. This two-ply search permits some anticipation of possibilities, but is still not good. The program gets stronger as it looks at more and more plies, avoiding moves that lead to the opponent's advantage, and seeking moves that lead to its own advantage at a subsequent point. This ability to look ahead is characteristic of stronger human players, although not carried out in such a mechanistic way. The number of plies that can be examined is limited by the time each player is allotted for making his moves.

In the average chess position there are something roughly 36 legal moves available. Therefore to exhaustively examine one ply requires 36 move evaluations, to evaluate two plies requires 36 evaluations for each of the first 36 possibilities (i.e. 36^2), and to evaluate n plies requires 36^n evaluations. Put slightly differently, each additional ply increases the computing requirement by a factor of 36. Clever programming has permitted this naive exhaustive approach to be improved upon, and leading programs may prune the number of positions to be evaluated down to about 6 per ply. This means that the factor of 36 provides one move by each side (two plies), and the cost of n plies is reduced to 6^n evaluations.

It has been found that the U.S.C.F. rating of computer chess systems goes up almost linearly with the number of plies examined. Thus we have a linear increase in benefit demanding an exponential increase in computational effort.

The leading system (Deep Thought) has achieved grandmaster level by looking ahead 10 plies. By the foregoing estimate this would require examining some 60 million positions per move, or about 300,000 positions per second to comply with tournament time limits. To look ahead two additional full moves (4 plies) requires the speed to increase by more than 1000 times. Since the chess algorithms can exploit parallelism to some extent, this will likely be achieved and would be close to world championship level play.

The places that achievable computer power will influence most us are probably in advanced interfaces and in advanced information management techniques. Today we have achieved capabilities to store large amounts of data, to use sound and graphics and imaging techniques to display and analyze it, and to use the internet obtain additional material from remote sources. Such uses of the computer have created a class of *digital media* that combine and transcend print, film, audio, and video techniques. They are characterized by mixing together the traditional media, and by an interactive capability to navigate through the contents. These methods are becoming available in educational settings, and on home computers thanks to multimedia productions on CD-ROMs.

Experiments at the University of Missouri and elsewhere have revealed substantial capabilities within the typical desktop or laptop machines of today. The limitations which have been encountered can be quantified, and both device improvements and parallel methods have been identified to move us forward into "virtual reality" mediated learning settings. These opportunities fall comfortably within our technological reach, even as the curve is bending over. As has been true throughout the computer age, the greater challenge is the harnessing of these developments in the service of curricular innovation and quality of life.

Images in Data Bases

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Abstract

Food composition data base developers have available to them technology which permits the incorporation of images, in addition to standard numeric and descriptive data. For maximum usefulness, the images should be used to document the samples as collected and/or prepared (e.g., after cooking, reconstituting); to verify expanded descriptions (e.g., sample maturity); to identify with scientific names, for the present and the future as they can change; and to accompany the numeric and descriptive data into user applications' software packages. Presently there are over 200 food images in the New Zealand Food Composition Database, ranging in size from 25 KB to more than 2 MB each, and occupying a total of about 80 MB of disk space. The process at Crop & Food Research involves digitizing photographs of the actual food samples using an optical scanner at 400 dpi resolution. Other technologies in use include archiving using CD-ROMs; fractal compression with its resolution-independent images, color preservation and extreme compression ratios (600:1); and documenting new samples using a digital camera. To date, several important uses for images have emerged. These include identification of some finfish species, where the common name could relate to several different scientific names; data validation where intensity of the orange color led to accepting ß-carotene values outside the expected range; food intake surveys where food descriptors were difficult to translate, such as lean:fat ratios in beef cuts; more complete capture of details from food packages, including batches and barcodes; and for international interchange of food composition data. The process is so simple, and the information so valuable, that there is little reason to omit this important step in food composition work.

Documentation by Image

Ideally, images should be used starting at the sample collection stage. In New Zealand, food samples are collected and assembled in the laboratory. Samples are first photographed intact and raw with appropriate cross-sections exposed. The samples are often photographed again after consumer-type preparation. A scale definition (usually a metric ruler) and a color index panel (usually a Pantone sheet) are also included in most photographs.

Food packaging and labels are also routinely photographed, allowing capture of barcodes, batch codes, and other coded and cryptic information. All this is done in addition to the recording of word descriptors and detailed text containing the standard documentation details such as age of sample, date of sampling, geographic region, common and scientific name, physical state, processing, packaging materials, etc.

The photos are then digitized in a PCX format using an optical scanner at 400 dpi resolution. Much higher resolution is available, but there is a trade-off between resolution and space required to store the image. Presently, there are approximately 200 PCX images in the NZ Food Composition Database, occupying about 80 MB of disk space. The size of the individual files ranges from 25 KB for a simple black and white bread wrapper, to 2 MB for some large, highly colored fruit and vegetable images. Disk space requirements vary depending on size of the image, number of colors, the image resolution and the compression technology used.

Various manipulations can be done to achieve efficient storage. One NZ beverage record represents a composite of three different brands of powdered drink mix. The packaging scanned in 256 colors occupies 630 KB; this same file compressed with PKZIP occupies 416 KB; and as a GIF file, 93 KB. The same information contained on the packaging, when entered into the database as text, occupies a mere 30 bytes. Figure I shows disk space comparisons of three food records, as full color PCX files, greyscale PCX files, compressed (ZIPped) full color PCX files, PCX files converted to GIF and JPG, and information captured as plain textual descriptions.

Using a number of different software package and shareware, images stored in PCX format can be transferred to media as other less byte-consuming formats such as GIF. This is important because users will have different hardware and software products available to them. GIF and TIFF have become industry standards, and JPEG with the ISO and CCITT backing (1) is becoming popular for compressing still images for storage. Exchanging of images will be facilitated by having image format flexibility.

The Hardware

The ability to view images is dependent on the hardware available. Images require, as a minimum, a Super VGA monitor which can display 1024 x 768 pixels in at least 256 colors. Some images require a 1 MB video card capable of displaying 32,000 colors from a palette of over 16 million colors. These hardware items are widely available and in common use around the world.

Other media

Flopticals have been used already in the exchange of images between New Zealand and INFOODS. Floptical disks are 21 MB in size, compared to the 1.44 MB size of standard 3.5" disks. Although this capacity is helpful, other media are required for exchanging data bases full of images, and this is where compact disks become essential. Third party software will allow integration of compact disks and proprietary technologies such as Photo-CD with food composition data bases. Many information systems have been developed using CD-ROM technology. Conventional information retrieval techniques including full-text searching and relational databases are integrated for accessing information stored on the CD-ROM.

Limitations

There are some limitations with using images in food composition data bases. For example, an image cannot be searched in the same way as text files. The image of an artificially sweetened beverage will identify ingredients, one of which may be aspartame. However, the image files cannot be searched for the presence of aspartame the way a descriptor text files or code files can. This is one important reason why images will not substitute for documentation by words or alphanumeric codes.

Uses of Images

Data Validation

Verification of information has become the most valuable use to date of the effort to document by images. Analysts and compilers of data bases sometimes question data, and images have on many occasions allowed us to make decisions about accepting or rejecting the results of some nutrient analyses. For example, very high values for ß-carotene in New Zealand apricots were questioned a few years after the analytical work. More recent work on apricots produced values which were significantly lower. We examined details of methods, compared the sampling plans and sample preparation methods, and finally resolved the problem by comparing images of the actual samples used. The images showed that the earlier samples had a much deeper, darker, orange color than the more recent samples. Another example of data verification involves the New Zealand muttonbird. Its iron content is higher than that expected for a bird, and resembles the iron content of beef and lamb. The image shows the flesh of this bird is a deep red color, suggesting that the high level of iron is not unreasonable.

Food Intake Surveys

It is often difficult to match an item in a diet history or recall survey with an equivalent record in a food composition data base. Even in an interview situation where the foods are selected off a computer screen, some judgments are required which many people cannot make without the benefit of visual examples. It is far easier for most people, nutrition professionals and lay alike, to select a picture which looks like what they would consume. For example, most people could not say with confidence what the ratio of separable lean to separable fat was in the piece of meat they ate, although lean:fat is a common descriptor used in food records.

International Interchange

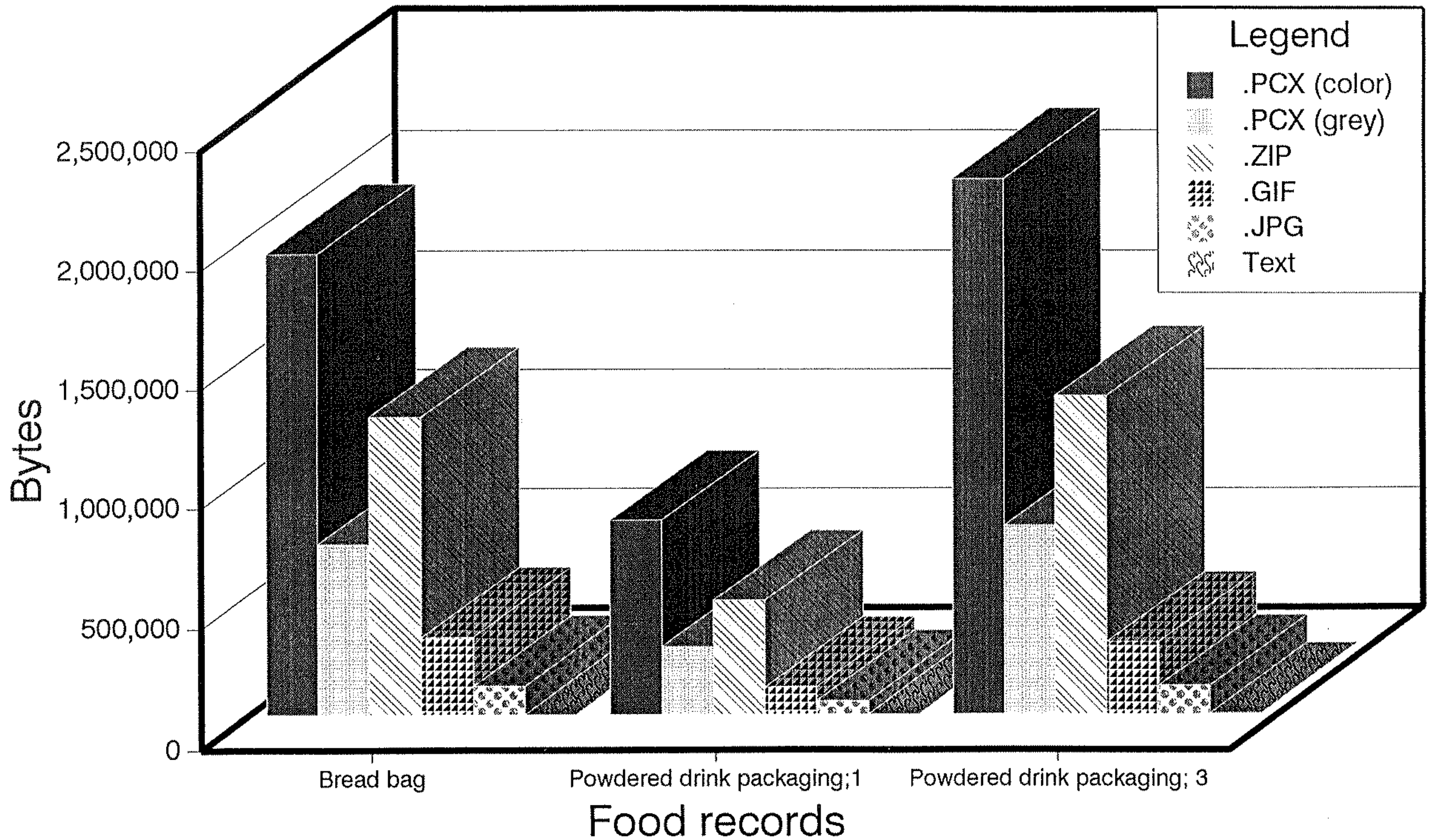
International interchange of food composition data, and more importantly, international trade in food products, reveals the challenge of relying on word descriptors. However comprehensive and however many language translations are provided, words alone will never be enough. Every country has unique items in its food supply and food composition data base. New Zealand has feijoa, pukeko and karaka berries; Australia has witchetty grubs, walleroo and cassowary gum. Most people outside of the region would have no idea what these foods are.

Even more challenging than unfamiliar-sounding foods, are familiar-sounding foods which are remarkably different from their like-named counterparts. For example, the New Zealand kumara, with the alternative name sweet potato, is quite unlike the North American sweet potato; the New Zealand pumpkin is unlike the typical North American pumpkin. The differences seen in the nutrient composition are not so surprising when the physical differences are shown with an image of the food.

INFOODS has considered the issue of images in food composition databases (2), and an image element is included in the interchange model (3). The structure for interchange using the INFOODS' model requires elements that indicate the picture encoding type as well as providing the actual image. A comment element may also be used. The images are subsidiary to the classification element, which is the first immediate subsidiary of the food element. Images associated with a cut of meat record might include a carcass diagram showing the position of the cut and a photograph of the cut itself. These would be included in an interchange files as follows:

<image><pcx/> *the first image itself in PCX format* </pcx/><cmt/>beef carcass diagram with cut sites identified</cmt/></image>
<image><gif/> *the second image itself in GIF format* </gif/><cmt/>image of cut</cmt/></image>

Disk space requirements



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NUTRITION LABELING

FDA's Database Review System

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Industry Databases

Databases for Frozen Foods

Robert Garfield, *American Frozen Food Association*

Ingredient Databases

Edward Seguine, *Guittard Chocolate Company*

Labeling Regulations and Methods of Analysis

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The Food and Drug Administration's Database Review System

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Background

In 1973, the Food and Drug Administration (FDA) made available a manual, Compliance Procedures for Nutrition Labeling, which explained how the agency would conduct evaluations of the nutrient content of retail products to determine if the information on the label was in compliance with FDA nutrition labeling regulations. The 1973 manual was updated, revised, and replaced in 1993 by the FDA Nutrition Labeling Manual: A Guide for Developing and Using Databases. The 1993 manual was supplementary to the nutrition labeling regulations which were revised and published in the Federal Register on January 6, 1993. The manual describes the development of acceptable nutrient databases and discusses the statistical methodology to develop nutrition labeling values. It was written specifically to assist the food industry in developing nutrition labels for food products that comply with the nutrition labeling regulations.

In the nutrition labeling regulations, which were published on January 6, 1993, FDA provided information regarding the use of databases for nutrition labeling. FDA encouraged manufacturers who wished to use a database for nutrition labeling to follow the statistical procedures outlined in the 1993 FDA Nutrition Labeling Manual and to have the database reviewed and approved by FDA. Specifically, the agency stated:

> If a manufacturer wishes to use a data base for nutrition labeling, it is advantageous to follow the statistical procedures outlined in the manual and have the data base accepted by FDA. If the agency finds that the nutrition label of a product which is based on a data base that has been accepted by FDA is not in compliance with § 101.9, FDA will not take immediate action against the product, provided that the company has followed good manufacturing practices in producing the foods. Instead, the agency would work with the manufacturer to resolve the compliance issue. Action would be taken only if noncompliance was the result of failure to follow good manufacturing practices.

When FDA refers to a database in the nutrition labeling regulations, it is referring to the collection of data and other relevant information about an individual food. (The term "database" also refers to reference databases containing many foods, such as USDA Agriculture Handbook No. 8; however, FDA is not using the term in this way.) The relevant information includes previous studies about variables that affect the nutrient content of the food, sampling design, analytical methods, laboratory quality control, and statistical treatment of the nutrient composition data. Databases that are submitted to FDA may contain proprietary information that cannot be released by the agency to others who may request it.

In the January 6, 1993 publication, FDA made it clear that the data used for nutrition labeling are the choice and responsibility of the manufacturer. FDA stated

It must be noted that submission of a data base to FDA for review and acceptance is voluntary. The agency has not prescribed how an individual company is to determine nutrient content for labeling purposes. The choice of a data source is the prerogative of the manufacturer. The manufacturer needs to be judicious in this selection, however, to ensure that the product labeling is in compliance with the regulations.

The nutrition labeling regulations (21 CFR 101.9(g)(8)) state that compliance with nutrition labeling regulations "may be provided by use of an FDA approved data base that has been computed following FDA guideline procedures and where food samples have been handled in accordance with current good manufacturing practice to prevent nutrition loss. FDA approval of a data base shall not be considered granted until the CFSAN has agreed to all aspects of the data base in writing." The regulations further state that "approvals will be in effect for a limited time, e.g., 10 years, and will be eligible for renewal in the absence of significant changes in agricultural or industry practices."

Current Situation

In response to FDA's statements about databases, several food companies and trade associations have submitted databases and ingredient database systems to FDA for review and evaluation. (Ingredient database systems determine the nutrient values for foods from the nutrient content of their ingredients.) Approximately 48 submissions are currently under review at FDA. Over the past year, the agency has been developing a review system to provide consistent and thorough evaluations of the submissions. FDA developed and made available the Guide to FDA's Database Review System to provide assistance to industry, trade associations, and other groups who are developing and submitting food composition databases for use in nutrition labeling to FDA for review and evaluation. The Guide describes the FDA database review process and provides the criteria that FDA currently uses for individual food databases. The Guide also addresses criteria for ingredient databases; however, this section is still under development.

The review of individual databases consists of four parts:

1. Data reasonableness and variables
2. Analytical methods (shipping, handling, storage, quality control, sample preparation, laboratory controls)
3. Sampling design (sampling objectives, target population and sampled population, sampling frame, sample size, sample collection and handling, types of test samples)
4. Statistical treatment of data (statistical analysis and calculations of label values)

Reviewers with specific expertise in these four areas evaluate the databases using the criteria specified in the Guide.

The review of ingredient database systems consists of a series of questions that relate to:

- the suitability of the ingredient database system for the particular food products
- background information regarding the development of the system
- variables that affect the nutrient content of the food and/or the major ingredients
- the ingredient database (number of ingredients, source of data, completeness of database, how information is collected and reviewed)
- procedures to ensure accuracy and currency of the database
- corrections for moisture and nutrient loss
- validation process; sample collection and analytical methods for validation; comparison of calculated and analytical values
- the software system description and validation.

The reviewers respond to the questions and provide overall summary evaluations for the systems.

Several problems have become apparent during the review process. First, FDA resources for database review are not adequate to handle the volume of submissions received by the agency. FDA is trying to decide how to accommodate the interest in agency review and approval for databases, and the assurances provided by that approval, while maintaining a system that is responsive to review requests, i.e., a system that provides reasonable, timely responses to requests for agency review but does not overwhelm its resources.

Secondly, the rigorous standards set in the 1993 FDA Nutrition Labeling Manual are not being reached by the submissions. These standards are generic (for all foods) and represent the ideal situation. FDA acknowledges the effort of industry to develop nutrient databases for nutrition labeling, but notes that there is a gap between the databases/database systems that FDA would like to receive and the databases/database systems which the food industry is currently submitting. The primary problems found during the review process include lack of documentation, lack of information about variables that affect nutrient content, and inappropriate sampling designs. Although several database evaluation letters have been sent to industry from the agency, FDA is trying to find a workable solution that is fair to industry, but still provides consumers with appropriate, useful labeling information.

The FDA Nutrition Labeling Manual evolved during the period of voluntary nutrition labeling when only those industries truly interested in nutrition labeling were developing databases for their products. Nutrition labeling is now mandatory for most manufacturers, and many of them are providing nutrition labeling for their products for the first time. Industry appears to be concerned about the "stringent" database review criteria developed by FDA. The agency receives many visits, calls, and questions from industry regarding database development and use and the status of their submissions. We do our best to answer their questions, to meet with them, and provide assistance without showing partiality or favoritism.

Actions and Directions

Based on the database review concerns noted above, i.e., inadequate resources and standards that industry has difficulty meeting, FDA believes that some modifications in its approach to databases may be necessary. The agency is considering the possibility that it can adequately evaluate a database using less information than it would receive under the guidance in the FDA Nutrition Labeling Manual. It is also considering the possibility that the system may be more flexible and responsive if manufacturers were authorized to begin labeling their products based on an abbreviated, preliminary review by FDA. Such a system could offer a manufacturer some assurance that FDA would not take action against its products, although the manufacturer would have to agree to move quickly to modify its labeling if the agency found the database to be unrepresentative or inadequate.

FDA has taken two primary actions with regard to databases. One was to grant interim use of submitted databases/ingredient database systems until May 8, 1995. All those submitted to FDA before May 8, 1994 (except those concerning raw fruit, vegetables, and fish) were granted this interim use period. Databases for raw fruit, vegetables, and fish are considered under another regulation, the Voluntary Nutrition Labeling Program. FDA is developing the database for foods in the voluntary program to promote consistent use of the same data in retail stores across the country.

The second action is that FDA solicited comments on all aspects of the FDA database review process. This request for comments is found in the proposal concerning the Voluntary Nutrition Labeling Program which was published in the Federal Register in May 1994. This proposal specifically asks for comments on FDA's database review process and makes available the Guide to FDA's Database Review System. The agency is requesting comments about the evaluation criteria as related to (1) the nature and rigor of the evaluation process, including the need for information on the source of the data, number of samples, sampling design, analytical methods, statistical treatment of data, and proposed quantitative label declarations; and (2) the appropriate basis for an "interim" approval and guidelines to determine key minimal criteria for such "interim" status, as well as guidelines to establish follow-up procedures and time lines to ensure that database developers will continue to collect data and improve their databases intended for nutrition labeling purposes.

FDA will consider and respond to all comments concerning database reviews that are received in response to the proposal, and will revise the database review process accordingly. The end result will hopefully be a database review system that meets the needs and fits within the resource constraints of industry, consumers, and FDA.

Databases for Frozen Foods

An industry's experience implementing nutrition labeling for frozen fruits and vegetables utilizing the provision of the Nutrition Labeling and Education Act of 1990 allowing nutrient databases.

Robert Garfield, American Frozen Food Association

The importance of regular consumption of fruits and vegetables is well known. Under the requirements of the Nutrition Labeling and Education Act of 1990 (NLEA) a number of frozen fruit and vegetable processor members of the American Frozen Food Institute (AFFI) felt it imperative to extend to the consumer a consistent message about the superior nutritional quality of frozen fruits and vegetables. Hence, the concept for a froze.,i fruit and vegetable database was conceived in 1990. Since then, AFFI has submitted 26 database proposals to the Food and Drug Administration (FDA). The first, a database for frozen broccoli, was submitted to the Agency in December of 1992 and is the only database to date which has received two-year interim approval from FDA. AFFI is currently working with the Office of Food Labeling, FDA, to extend interim approval to the remaining database proposals. Simultaneously, AFFI is moving forward with the next phase of the project which includes a ten-year program to sample, analyze and evaluate the nutritional quality of each of the 26 frozen fruit and vegetable commodities.

Errata Page

Page 56:

Speaker Affiliation :
Mr. Garfield is with the American Frozen Food Institute.

Last Paragraph, Line 5:
"frose.,i" should be "frozen"

Page 57:

Paragraph 1, Line 3:
"abouteach" should be "about each"

Paragraph 2, Line 10:
"ajay" should be "may"

Paragraph 3, Line 11:
"aay" should be "may"

Note: The errors in the text of Mr. Garfield's paper were introduced when it was scanned for the proceedings. I regret that I failed to notice these errors before we went to press. Loretta W. Hoover, Co-editor

[redacted]

The Concept of a Database

We are enthusiastic about the database for frozen fruits and vegetables because the ability of consumers, national and regional brands and private label marketers to have access to consistent nutrition information abouteach commodity is so important. Members of the database also believe the value of the data is worth the cost of preparing the database and is advantageous to their company as well as the frozen fruit and vegetable industry as a whole. Finally, many processors believe the "safe harbor" being accorded by FDA to food processors who are involved in an approved database is worth pursuing.

Objective.

AFFI's objective is to prepare databases which accurately reflect the nutrient content of frozen fruits and vegetables as processed by the participating members. While we understand that consistency and accuracy are the cornerstones of a database study, AFFI accepts that fruit and vegetable attributes may vary depending on farm practices and nature. The AFFI challenge was to establish database proposals which matched the mathematical science of statistics, the complexities of nature, farm practices and time. The conservative nutrient numbers submitted to FDA in our database proposals are a start and reflect reputable historical nutritional data available for many frozen fruits and vegetables, although statistical treatment of the data could not be quantified. Interim values, therefore, were based on an arithmetic mean of the nutrient values established from available datapoints, establishing a "baseline" for the new database study. The purpose of our ten year study is to rectify any inconsistencies which ajay apply to the current nutrient profile.

Sampling Strategy.

AFFI's sampling strategy reflects the result of discussions with FDA and industry scientists and professionals assembled from the companies participating in the database. First, the study has been weighted so that a significant portion of the samples will be taken during the first two years of the study. Once those samples have been analyzed and reported (within the third year), the values for the nutrition panel will be adjusted as necessary to reflect current nutrient information. By weighting a significant portion of the samples during the first two years AFFI hopes to minimize label changes and concentrate our efforts. The strategy requires frozen fruits and vegetables grown in different regions of the country and harvested during several seasons as well as various cuts and types to be statistically analyzed. The strategy uses an experimental design with serial analysis of stored samples: four replicates will be collected of each sample, with nutrient analysis at 0, 4, 8, and 12 months. The goal of this part of the strategy is to better characterize nutrient loss which aay occur over time for a variety of frozen fruits and vegetables. Production lots will be sampled during the beginning, middle and end of the run to reflect a broad cross section of each product. Finally, the length of the study proposed is 10 years, with reports to FDA and members of the database occurring approximately every two years. All facets of the strategy will be reevaluated at this time and adjustments will be made to reflect the current state of knowledge about the nutrient content of each frozen fruit and vegetable in the study.

Sample Size.

AFFI's contractor conducted a nutrient literature search using AFFI's existing nutrient database converted to 85 - gram reference amounts. Those numbers were compared to the Produce Marketing Associations (PMA's) data. From the results of these activities, including more current nutrient analyses conducted by database members, an estimated sample size was calculated. A proposed sample size was then extrapolated for each nutrient based on appropriate criteria. Finally, a "baseline" label was established utilizing the "FDA Nutrition Labeling Manual," accumulated datapoints for each of the 26 frozen fruits and vegetables, and the appropriate statistical analysis.

Current Status.

In April, 1993, AFFI received a two year interim approval of its frozen broccoli database. Based on that approval, AFFI submitted 25 more databases to the Agency by the Fall of 1993. We have received a response from FDA on two of those databases, frozen carrots and green beans, requesting more information. AFFI has responded to the questions posed by the Agency and in that response has requested approval of all remaining databases. Simultaneously, we are moving forward with the sampling portion of the study. AFFI has employed the services of Technical Assessment Systems, Inc., (TAS) to maintain the database for the next 2 years and is actively recruiting a laboratory to perform the nutrient analysis. We intend to begin sampling frozen broccoli in the next few months to be closely followed by the remaining 25 frozen fruits and vegetables.

Like a Kid In a Candy Store

Edward S. Seguine, Guittard Chocolate Company

Background

The phrase, "Like a kid in a candy store!" describes in seven words what our industry is all about---delight, enjoyment, and a bewildering and seemingly endless array of variety---so much variety that there is no way you could experience each and every confectionery delight---a choice must be made. While eminently attractive to the kid in all of us, the candy aisle in the grocery store is only a small reflection of that variety which awaits you at a retail confectionery store.

This variety of products, while delighting both the palette and imagination of the buyer, turned into a nightmare with the passage of the NLEA. Most retail candy stores produce and sell between 100-200 different candy "pieces" plus assortments. The ease with which new products can be made is astounding. A confectioner can have an idea for a new confection in the morning and be offering it to the customer that afternoon. The prospect of having to perform laboratory analyses on each and every product and assortment was more than scary to the industry.

Three associations cover the range of businesses within our industry:

NCA	National Confectioners Association
RCI	Retail Confectioners International
CMA	Chocolate Manufacturers Association

Although their membership profiles overlap, the NCA represents large candy sold through the normal distribution system. The RCI generally represents smaller confectioners selling through candy stores and companies manufacturing for department and specialty stores. The CMA represents the chocolate industry covering the range of products from chocolate candy in retail distribution (Hershey, Mars, Nestle, etc.) to chocolate sold industrially in 10 lb. bars to NCA and RCI type companies for remanufacture.

NCA/RCI/CMA Nutrition Labeling Database Committee---Database Program

Shortly after the passage of the NLEA, the three associations formed a committee to create a rapid and economical means of developing nutrition profiles for our products using the database provisions of the then proposed regulations.

NCA/RCI/CMA
Nutrition Labeling Database Committee

The program developed by the Database Committee had to be consistent with the product variety and creation capabilities of the industry. We retained the consulting and development services of Ms. Charlene Rainey, President of Nutrition Network, to develop a complete database program which would meet these needs as well as meet the guidelines in the FDA's *Guide for Developing and Using Databases*. After a truly massive amount of work, the first phase was submitted to the FDA in July, 1993, and the last phase for their review this past March.

Notice that I have not described this as an industry "database". It is a complete database program that consists of four parts:

1. A database of ingredients used in the confectionery industry
2. A calculation program that uses recipes, finished product moistures, and ingredient nutrient values, calculates nutrient profiles and performs regulation mandated rounding
3. A modeling program verifying that finished product nutrient profiles can be calculated from ingredients used in the recipes
4. A quality management program to insure individual company accuracy, long term accuracy of program results, and a mechanism of specifying the quality of individual ingredient data and of improving those nutrient values used in the data base program.

For the purposes of this program, the target population was restricted to confectionery products and provides values only for the 14 mandatory nutrients. We specifically excluded from the program:

Nutrient content or health claims
Nutrient labeling of optional nutrients
Nutrient fortification and/or supplementation (enrichment)

Structure of Products in Confectionery Market

The development of the complete program rests upon two key characteristics of our industry---

1. Common basic ingredients used in the industry
2. Common processing conditions used in the industry.

Our industry is founded on the physical chemistry phase structure of sugar/corn syrup/water systems. The taste and textural properties of our products are integrally related to this one universal foundation. Based on this recognition, the target population was divided into five primary confectionery categories based on the ingredients and processing conditions used. In many cases, a single confection may be a combination of confections from several different categories.

Category I Sugar Based Hard Candy
The simplest of the categories, this consists of pressed tablets (such as mints and breath savers), uncooked confections made with fondant sugar, syrups and creme centers, and hard candies. Basic ingredients are sugar and corn syrup.

Category II Sugar and Fat Based Caramels and Toffees
This category consists of truffles on the low cooked end, caramels and fudge in the medium cooked range, and brittles and toffees at the high cooked end. Basic ingredients are sugar, corn syrup, fat, and optional dairy ingredients.

Category III Sugar and Whipping Aid Based Aerated Confections
This category is easily recognized as marshmallows, nougats and other aerated confections. Sugars and water are cooked as for Category I hard candy with whipping aids added at lower temperatures prior to whipping.

Category IV Sugar and Gelling Agent Based Gelled Candy
This category is easily recognized as the ever popular jelly beans and gummy bears. Basic ingredients are sugar, corn syrup and gelling agents such as pectins, agar, or starches added to the cooked sugar mass at lower temperature.

Category V Chocolate/Cocoa and Specialty Fat Compounds
Chocolate speaks for itself and consists of sugar, chocolate liquor, cocoa butter and milk. Compound coatings can include these same ingredients as well as cocoa powder and are made from specialty vegetable fats.

The complete database program works for our industry because of this structure. Now we go on to review the components of the program.

Ingredient Database

The ingredient database specifically covers ingredients used by the confectionery industry. To develop this database, association member companies and other industry companies solicited nutrient information from their suppliers. These were then submitted to Nutrition Network. Unlike other survey sources, information returned from ingredient suppliers was provided with sample documentation (Appendix I) which provided information on a number of key factors about the information.

Ingredient descriptions and formulation information
Date samples were produced
Method of sample collection
Number of samples in composites
Number of production lots represent by composites
Laboratory certificates of analysis
Laboratory methodology

The sample documentation was designed to provide the following information about each ingredient, the nature of the sampling, and how the nutrient values were specifically determined. The purpose of this documentation was to provide a basis to judge the quality of the analytical data as it was used to develop the ingredient database. It then becomes possible for future efforts to improve the quality of the data on ingredients where the sampling protocol or analytical methodology currently provides data of limited scope.

Before entry of data into the database, ingredients were quality checked by Nutrition Network to assure accuracy.

- Completeness of data for mandatory nutrients plus moisture and ash

- Comparability of data with other known values for similar ingredients reported by other manufacturers or in the literature.
- Proximate values were screened to asses the exactness of the data (carbohydrate, fat, protein, moisture, and ash should sum to near 100%)
- Calories were recalculated to affirm correctness and, where appropriate specific energy factors were used
- Data were converted to appropriate consistent units throughout the database
- Data and data entry were error checked to insure accuracy of the values in the database

Using this process, over 1000 ingredients in use by the industry were installed into the ingredient database portion of the program.

Calculation Program

Given the nature of the ingredients and processing used in the confectionery industry, calculations are simple and are based on the principle that "what goes into the candy kettle, adjusted for moisture loss, is what comes out." Within the industry, ingredients are carefully weighed or volumetrically measured and added to a "candy kettle" for cooking to the desired end point as measured by cook temperature. Most of you are familiar with many of the terms involved in the syrup cooking stage from your own cooking experience at home. These terms are in common use throughout confectionery and dessert cookbooks:

Cooking temperature terms	
cystal syrup	219^{o}F
thread	226
pearl	230
blow/soufflé	235
feather	241
soft ball	245
hard ball	253
crack	268
caramel	302

Kettle cooked ingredients, with specific moisture contents, are then combined with other ingredients and with other cooked ingredients to make a finished confection. An example of this "assembly" would be a Snickers bar consisting of nougat, caramel, peanuts, and overall enrobed in chocolate.

The texture and physical structure of confectionery products depend largely on the syrup, crystalline (grained), and glassy phases created when sugars and water are combined and heated. The finished product texture and structure is governed by this phase relationship and the ingredients and processing used are standardized for each product. The nutrition profile is standardized along with the taste and texture for each.

Following this principle, Nutrition Network developed a PC based computer program for our industry which combines the ingredient database with a calculation program that allows companies to input their specific recipe and its final moisture content.

It then calculates both exact nutrient profiles and rounded, labeled values of nutrients. The program also carries with it basic data on ingredient suppliers and analytical laboratories. The calculations are straight forward.

The company selects the ingredients for their recipe from the database, indicates the percent, provides the serving size information, and final moisture and the program calculates the profile. A provision is made in the program for identifying a product as a "base product" which then makes the results of the calculation available to other calculations using this as an ingredient. The Snickers bar is an example of this where the nougat, caramel, and the chocolate are each individually calculated as base products, and then "assembled" into the finished product which also includes peanuts.

A variety of reports and formats are available from the program depending on the needs and the desires of the company. The program itself performs all regulation-required rounding from the exact values given the declared serving size. Several of these reports are shown for typical confections in Appendix 2.

One key component of the modeling program follows the premise that ingredients must be specifically located in the database. Whey is not a substitute for nonfat milk, margarine is not a substitute for butter, one brand of shortening must not be substitutes for another, individual chocolates (differing from one another in milk, chocolate liquor, and fat content due to viscosity) are each unique, etc. We subscribe to the advertising programs of both Porsche and Maxwell House: ***Accept No Substitutes!*** With over 1000 ingredients and a program to continue to add ingredients as gaps are identified, there is little need to make substitutions that could risk the integrity.

Modeling Program

In order to verify the basic premise that what goes into the candy kettle comes out (adjusted for moisture loss), member companies submitted complete confectionery recipes and laboratory certificates of analysis showing nutrient profiles for the confections. The confections chosen were generally products in full market production and distribution and covered all five product categories. Using this base, over 420 independent comparisons were made between the calculated label value and those determined by laboratory analyses. 97% (406) of the comparisons were within FDA compliance guidelines. Of the 14 values outside of the compliance limits, all were in the very low range of values for that specific nutrient.

Simply put, calculations work for our industry.

Quality Management Procedures

The quality management program consists of four critical control points.
1. Documentation of nutrient values
2. Documentation of the recipe
3. Performance audits of the calculation program and all updates
4. Ongoing auditing of lab calculations and ingredient nutrient profiles

Responsibility for implementation of these control procedures is split between the developers of the database and the users of the software.

The documentation of the nutrient values for the ingredients, the first critical control point, has already been discussed. This is the specific responsibility of the NCA/RCI/CMA as executed by Nutrition Network, Inc.

The second critical control point is the documentation of the recipe which is the responsibility of the manufacturer. Recipes are the basis for all chocolate and confectionery products. Each product, or piece as it is called in the industry, and manufacturer has unique recipes and process conditions which make it necessary for the manufacturer to identify the control points for all of their products to assure the consistency of the recipe composition. In all cases, use of the modeling database require that documentation of these parameters be maintained for each product, including the assembly of assortments. The basic steps are:

1. Batch ingredient weight verification. Each ingredient must be weighted or measured volumetrically. If volume measurements are used, volume to weight conversions must be confirmed. This also includes programs to assure that only the listed ingredients are used in the recipe—not substitutions.
2. Moisture content verification. Tests for final moisture content or alternately the moisture loss must be conducted on each product. Note that once confections are made, little moisture loss or gain occurs without dramatic disruption of the product taste and texture. Hence, little change occurs or is allowed in the trade.
3. Piece weight verification. Assembly ratios for individual pieces (e.g.: percentage of chocolate on a piece) are verified and controlled to assure accurate proportioning of "base product" ingredients on the production lines.
4. Ingredient count for individual pieces. In some instances, such as some products containing nuts, individual piece count is controlled.

The third quality control point is the audit of the computer calculations. This was done initially by Nutrition Network, Inc. and the NCA/RCI/CMA Database Committee following development of the program and is an integral part of all "beta testing" of program additions and revisions.

Fourth, the NCA, RCI, and CMA have recognized the need for ongoing improvement in the quality of the data contained in the ingredient portion of the database. While present efforts are focused on the addition of ingredients to the database to cover over the few initial gaps in the data, longer term efforts will be focused against improving the quality of the nutrient values in the database itself.

Bottom line to the database is that it works by providing highly accurate nutrient values and allows confections to provide the nutrition information for labeling with speed and economy. While label printing remains a significant issue given the wide variety and broad range of both products and packaging, the recently passed Small Business Exemption allows the small confectioner time to work through their product lines in order of volume sold.

As an industry, we are appreciative of the help which we have received from all of the members of the industry, both members and non-members of the three associations; Nutrition Network; and the staff of the FDA.

Nutrition Network Labeling System

Monday, May 09, 1994

Product Recipe - Summary

Company: Classic Candy Fudge Co.

Fudge, Chocolate

2 Squares **Serving Weight** **35 grams**

Ingredient Name	Percent	Cost
Sugar, Granulated, All	30.9	
Sugar, Fondant, Easy Fond	16.6	
Corn Syrup, 43/43 DE, Staley 1300	15.4	
Water	14.3	
Milk, Sweetened Condensed, Whole	14.1	
Chocolate, Baking	8.5	
Salt	0.2	
Totals:	**100**	

SAMPLE DOCUMENTATION

CONFIDENTIAL PRODUCT INFORMATION FORM

Please attach laboratory certificate and answer the following questions to the best of your ability. Attach additional sheets as necessary.

Company Name: ______________________________ Phone: ____________________

Contact Name: ______________________________ Title: ____________________

Product/Ingredient Name: ____

As supplied to (company requesting this information): ______________________

Ingredients/formulation information: ____

____

How many samples were composited for this analysis? ________________________

How were the samples collected? ____

____

Were samples from the same production run/lot? ______________________________

On what date were samples produced? (if different dates, list number of samples from each date)

____

On what date were samples analyzed? ____________________________________

At which laboratory? ____

List analytical method used for each nutrient ______________________________

____

Please provide any other information you believe to be relevant to this research:

____

SEND LAB DATA AND COMPLETED FORMS

Nutrition Network, Inc.
One Technology, I-801
Irvine, CA 92718
Phone: (714) 753-7998
FAX: (714) 753-7989

THANK YOU FOR YOUR PARTICIPATION IN THIS IMPORTANT RESEARCH

Nutrition Network Labeling System

Product Nutrition Information - Mandatory

Monday, May 09, 1994

Company: Classic Candy Fudge Co.

Product: Fudge, Chocolate

Serving Size: 2 Squares **Serving Weight:** 35 grams **Final Moisture:** 7.3 %

Nutrient Name	Per 100 Grams	Per Serving	Label Value	%DV
Calories	375.867 cal	131.553 cal	130 cal	
Calories From Fat	57.823 cal	20.238 cal	20 cal	
Fat	6.840 g	2.394 g	2.5 g	4 %
Saturated Fat	4.069 g	1.424 g	1.5 g	7 %
Cholesterol	4.858 mg	1.700 mg	0 mg	1 %
Sodium	116.000 mg	40.600 mg	40 mg	2 %
Total Carbohydrates	82.213 g	28.774 g	29 g	10 %
Dietary Fiber	1.536 g	0.538 g	<1 g	2 %
Sugars	73.124 g	25.593 g	26 g	
Protein	2.497 g	0.874 g	<1 g	
Vitamin A	62.517 IU	21.881 IU		0 %
Vitamin C	0.460 mg	0.161 mg		0 %
Calcium	58.961 mg	20.636 mg		2 %
Iron	0.657 mg	0.230 mg		0 %

Labeling Regulations and Methods of Analysis

Jonathan W. DeVries, General Mills Inc.

Introduction

Adequate analytical methods for nutrients in foods, food ingredients, and food products are the basic first step in determining the nutritional adequacy of a food supply. Whether the nutrition data is ultimately used to educate consumers with information on the food label, or to build databases to study correlation between nutrient(s) and deficiency diseases, the assay used to provide the data must adequately determine the analyte of interest. AOAC International (formerly the Association of Official Agricultural Chemists and then the Association of Official Analytical Chemists) has been systematically validating methods for nutrition analysis for over 100 years. These validated methods provide competent laboratories with a means of supplying dependable data for nutrition labels and/or databases regarding the nutrition content of foods and food products.

Today I would like to cover three areas. I would like to cover the process and criteria for validation and acceptance of a method as an AOAC Official Method. Second, I would like to review a recent assessment of the adequacy of the Official Methods that are available for Nutrition Labeling and generating data for Nutrition Databases. And third, I would like to present an idea for a methods validation scheme that might potentially be used to improve the method validation process for foods, providing better comparative data and more rugged methods for laboratories to use.

Procedures of AOAC International

Although it started as a group of agricultural regulatory chemists, AOAC International has a membership that now includes scientists from all walks of life, from over the entire globe, interested in improving analytical methodology and results. In the late 1800's, AOAC started publishing "Official Methods" as United States Department of Agriculture bulletins. By 1920, the AOAC's volume of validated methods had grown to the point where it warranted its own volume, and the *Official Methods of Analysis* was established. It has been revised and updated every five years since.

AOAC has adopted the collaborative study as a means of validating methods and evaluating their performance. A complete peer review system, including study of the method in multiple peer laboratories and multilevel peer review of the study results assures the validity of a proposed method for its intended purpose. The key to rugged effective validated methods in AOAC lies with the Associate Referee. The associate referee, appointed on the basis of his or her expertise in an analytical area, develops an analytical method to meet a need, or through knowledge of the literature selects an applicable method for study. After a requisite number of laboratories have been found to carry out a collaborative, the associate referee distributes methodology and samples, collects the data, develops a study report and submits a recommendation for method adoption to the Association. Assisting the Associate Referee is the General Referee who brings a broad knowledge base to bear on the study and its results.

When the General Referee and the Associate Referee agree that a method performs sufficiently well to be considered as an Official Method, the method is submitted to an AOAC statistician and a safety advisor for review. Upon completion of these reviews, the method is sent to an appropriate Methods Committee for review and recommendation regarding Official Status. Methods committees are constituted of members chosen for their broad expertise in a given analytical area such as Food Nutrition, Food Toxins, or Drug Residues. Recommendation to the Official Methods Board to adopt a method as Official First Action requires agreement of two thirds of the members of the Methods Committee. If members of the Methods Committee raise significant issues with the method, the method cannot be recommended for Official Status until the issues have been addressed by the Associate Referee. Upon recommendation from the Methods Committee, the method is considered for Official Status by the Official Methods Board. The Board reviews the actions taken on the method, the review process, and assures consistency between methods and between methods committee reviews. If the method is given First Action Official Status, it is published in the Official Methods of Analysis. After first action status for two years, methods which have no unresolved negative comments or issues can be considered for Final Action Status, a status achieved through balloting by the entire AOAC International membership. There is no difference in the Official Status of Methods, whether first action or final action. Final action only indicates that a method has withstood some test of time with no substantive issues raised regarding its performance. As you can see, any method achieving Official Status through the AOAC process has had both substantial performance testing in multiple laboratories and peer review by scientists who are experts in the analytical area. In addition, it has had intense scrutiny by scientists in related endeavors.

Criteria for acceptance of a method for Official status are well established. The method must be submitted to participating laboratories written exactly as it is intended to be run. Participating laboratories are expected to run the method exactly as written. For a given collaborative study, participation by no fewer than 8 laboratories analyzing a minimum of five sample materials is required for quantitative methods. For qualitative methods, no fewer than fifteen laboratories analyzing a minimum of 2 analyte levels per matrix, 5 materials per level, and 5 negative controls are required. Obviously in both cases participation by more laboratories and the inclusion of more samples is encouraged. In extenuating circumstances, i.e. a particular method being considered has significant regulatory or commercial importance, but can only be carried out in five laboratories anywhere because only they have key instrumentation etc., special consideration is given. Obviously, such circumstances are rare.

After the collaborative study is complete, statistical outliers (laboratories and/or data points) are removed. Rejection of more than 2/9 ths of the data is considered excessive without an explanation, i.e. failure to follow the method by a laboratory. Since method performance will vary depending on analyte, matrix, and/or quantity, there are no hard and fast criteria for method acceptance or rejection. The combined judgment applied by scientific peer review throughout the entire method validation process serves to provide stringent criteria to be met for acceptance as Official Methodology. Experts from government, academia, industry, and associations, cognizant of the ultimate use of the methods being validated and of guidelines for adequate method performance, work in concert to produce top quality methods for the analytical community to use.

Nutrition Labeling-Methods Needs

I would now like to switch gears and discuss some recent activities undertaken by AOAC related to nutrition analysis. With the recent passage in the USA of the Nutrition Education and Labeling Act, concern arose amongst food consumers, producers, regulators, and laboratories providing nutrition analytical services, regarding the availability and adequacy of validated analytical methods to meet the requirements of the labeling act.

First a bit of history on the act itself. The act was passed by congress in November of 1990. It required the US Food and Drug Administration to promulgate proposed regulations for nutrition labeling of nearly all foods sold in the US. The US Department of Agriculture, although not legally required to do so, initiated activities to adopt labeling regulations essentially equivalent to those of the USFDA. The proposed regulations of November 1991, were open for comments with final regulations due in November of 1992. The final regulations were actually issued in January 1993, with an effective date of May 8, 1994 (July 8, 1994 for products under USDA jurisdiction). A few definitions might be in order here. NLEA stands for Nutrition Labeling Education Act, but as the long comment period went on, nutritionists were obviously excited and it became known as the Nutrition Lobbyist Enjoyment Act. The act will have a significant impact on Industry, Consumers, and Government Agencies. It is estimated that it will cost industry upwards of $1.5 Billion for the relabeling required, an estimated $1500 per product for small firms and $900 per product for large firms. Analytical cost will probably range from $750 for the 40% of US foods that need label changes to $1800 for the 60% of foods that had not been previously labeled. Research and development costs for products that will be modified somewhat for marketing advantages under the provisions of the act are hard to estimate, but run anywhere from $20,000 to $400,000 per product. Typically two to five months will be needed to redesign and print new packages. For consumers the cost of relabeling will be passed along in higher product prices. No money has been allocated for "Education", so it is expected that significant consumer confusion will exist after the label changes occur. Governmental agencies will incur extra costs for interpretation, analysis, and enforcement of the act.

As I said before, the effective date for NLEA is May 8, 1994 (this may even be moved to August 8, 1994 if President Clinton signs the bill currently passed by Congress), however other aspects of labeling have different effective dates, i.e. juice labeling in May, 1993, health claims in May 1993, and metric weight declarations in February, 1994. With the interpretation and explanation necessary for such a broad act, NLEA has occasionally been referred to as the National Lawyers Employment Act, or the that NFPA (National Food Processors Association) Loves (the) Extra Attention. The NLEA requires the mandatory nutrition labeling of most products and allows specified uses of nutrient descriptors and health claims related to nutrition.

I would next like to spend a bit of time discussing the format of the label, and some of the nutrient content claims. The label format(s) are rigidly specified for NLEA. Mandatory labeling is required for Calories, calories from fat, total fat, saturated fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, protein, vitamin A, vitamin C, calcium, and iron. Voluntary labeling is allowed for calories from saturated fat, polyunsaturated fat, monounsaturated fat, stearic acid (USDA products), potassium, soluble fiber, insoluble fiber, sugar alcohols, other carbohydrates, thiamin (B1), riboflavin (B2), niacin, vitamin D, vitamin E, folate, vitamin B12, phosphorous, iodine, magnesium, zinc, copper, biotin, and pantothenic acid.

Labels will list the quantity of a given nutrient, along with a % of daily value guideline for the consumer to use for comparison. The % of daily value is determined against either a Reference Daily Intake (RDI) value (typically for micronutrients) or against a Daily Reference Value (typically for macronutrients). For example, the daily reference value (based on 2000 calories/day) for fat is 65 g, for saturated fat is 20 g, for cholesterol is 300 mg, and for dietary fiber is 25 g. To encourage consistency in reporting of daily values, reference amounts relating to serving sizes have been published for common food items. Reference amounts are typically in common household units.

Nutrient claims can be made regarding the food product. However, if fat, saturated fat, cholesterol, or sodium exceed certain levels, this must be disclosed on the package along with the nutrient claim. Adequate analytical methods are obviously needed to assure compliance both with the spirit of the nutrient claim, as well as monitoring the disclosure level compliance.

Seven health claims are currently allowed on the food package label. Fiber containing grain products, fruits, and vegetables, and a reduction in the risk of cancer. Fruits, vegetables, and grain products that contain fiber (particularly soluble fiber), and the risk of coronary heart disease. Fruits and vegetables and cancer. Calcium and osteoporosis. Dietary saturated fat and cholesterol and the risk of coronary heart disease. Dietary fat and cancer. Sodium and hypertension. If certain levels of fat, saturated fat, cholesterol, or sodium are exceeded in the product, then health claims cannot be made.

The proposed nutrition regulations do allow the use of databases for generating label information, however, the extent of such usage is still open to question, due to questions regarding the quality and reliability of data in such databases.

For added nutrients (referred to as Class I nutrients), the nutrient must be present at 100% or greater than declared. For naturally occurring nutrients, (Class II), the nutrient must be present at a level at least 80% or greater than declared, but less than or equal to 120% of declared. Examples of nutrients that must be greater than 80% of declared are dietary fiber and potassium. Examples of nutrients that must be less than 120% of declared are fat, saturated fat, and sugar. Analytical variability is taken into account for enforcement, so well characterized validated methods are necessary for compliance monitoring.

AOAC Response

To deal with concerns regarding availability of adequate methods to meet the needs of NLEA, a special task force of the AOAC with members drawn from regulatory agencies, the food industry, academia, and analytical suppliers was formed. I will give a brief history of the task force, discuss the methods reviewed by the task force, and report the results of the task force efforts. The objectives of the task force were: 1). Determine which Official Methods are adequate to meet current nutrition labeling analysis requirements. 2). Determine which Official Methods need revisions or modifications to meet current nutrition labeling analysis requirements. 3). Determine which nutrient/matrix combinations require the development and validation of Official Methods. 4). Propose means by which AOAC International can supply needed methods and/or modifications. 5). Identify means by which reference materials might be incorporated into AOAC Official methods and into the validation process for AOAC Official methods, further assuring the quality and performance of those methods.

The task force began informally at the AOAC Annual International Meeting in 1991, and was formally appointed by the board of directors in December of that year. Efforts were initiated immediately to obtain feedback regarding the status of Official Methods used for nutrition labeling. A survey was conducted of laboratories carrying out nutrition analysis and using AOAC methods. An information gathering session was also held in March of 1992. A number of task force meetings were held in the succeeding months to carry out the assigned objectives and fulfill the task force's mission.

Under the proposed nutrition labeling regulations, up to 54 nutrition related items were either required or could be placed on the label. Everything from A (ash) to Z (zinc). To organize the task of evaluating methods for these analytes, the task force divided foods into 20 different matrix groups that were felt at the time to cover the scope of foods and food products. This resulted in 1080 analyte matrix combinations to be assessed regarding availability of adequate methods. NLEA immediately took on a new definition-Need Lotsa Extra Analysts. Individual committee members took upon themselves assignments to review AOAC methods on an analyte/matrix basis. After this preliminary review was done, the entire task force, along with aid solicited from others, reviewed the assessments of the individual members. The analyte/matrix grid of adequate methods began to fill in. As the task force progressed, the information being generated was regularly reported in the Referee to keep the AOAC membership informed of progress and to allow feedback. For example the assessment of adequate methods under the proposed regulations was published in the July 1992 issue of the Referee.

Initial review of adequate methods under the proposed regulations, indicated that 947 of the 1080 possible matrix/analyte combinations had adequate methods. This meant that 88% of the methods needs were addressed. In some cases, the Official Methods were deemed adequate for the need, but newer technologies can be brought to bear on the analyte/matrix combination to provide better methods at this point in time. An example might be vitamin A. The Carr-Price method provides adequate results for labeling purposes, however most laboratories today would rather use high pressure liquid chromatography and avoid handling the corrosive antimony trichloride. Therefore, although the task force accepted the adequacy of the Carr-Price method, it is recommending that validation of HPLC methods be undertaken.

As the list of adequate methods was being generated, a complementary list (or shall we say "uncomplimentary" list) of methods in need of validation or revision was also developed. This was published in October 1992 to alert members of methods needs.

Special Nutrition Labeling Issues

As the task force evaluated methods for nutrition analysis, a number of issues were raised. In particular, issues regarding methods for fat, dietary fiber, moisture, carbohydrates, standards and reference materials for Official Methods, and the need for a clear-cut means of determining if a method is applicable to all foods. Subcommittees of the task force were formed to address each of these issues.

Fat has traditionally been analyzed by a variety of methods depending upon matrix, analyst carrying out the analysis, and intended use of the resulting data. Typically, the result was dependent upon determination of some solvent soluble (solvents varied depending on the method) fraction of the food being analyzed. The task force realized that a single concise definition for fat was needed. AOAC International does not set definitions for nutrients, but provides validated analytical methods to quantitate defined nutrients. Therefore, the subcommittee recommended, and the task force concurred, that the regulatory agencies, the USDA and FDA, adopt a single concise definition for fat. The agencies responded by adopting a definition of fat as the sum of the fatty acids (regardless of source) in the food expressed as triglycerides. This concise definition provides a "gold standard" if you will for evaluating fat analysis methods in the future.

The carbohydrates subcommittee determined that methods for total, soluble, and insoluble dietary fiber are adequate. Sugar methods, in particular the HPLC methods with defatting steps, while adequate, should be further studied to assure validity across a broader matrix base. Complex carbohydrates as a nutrition label item had been included in the labeling proposal, but eliminated from the final regulations due to a clear definition of the nutrient, and lack of analytical methods to measure it. The subcommittee (and the task force) recommends a concise definition for complex carbohydrates be adopted and has committed AOAC to validating appropriate methodology at such time as a definition is adopted.

A complete listing of moisture methods, along with their characteristics has been published by the moisture subcommittee. As with complex carbohydrates, a clearer definition of moisture will be helpful in validating more concise methodology for this analyte.

The subcommittee on reference materials published a listing of commercially available reference materials for the nutrients requiring mandatory labeling in August, 1992. The subcommittee further went on to publish "Guidelines for the Preparation of In-house Quality Assurance Materials" in the May, 1993 issue of the Referee. Recognizing that reference materials was an ongoing task with significant follow-up required long after the nutrition labeling task force would be disbanded, the task force supported the formation of the first technical division of AOAC International, namely the Technical Division on Reference Materials. This division will continue the efforts initiated through the task force and will expand to reference materials beyond food nutrition. This division already has over 125 members and held its first annual meeting in conjunction with the AOAC Annual International Meeting in July.

I'll address the topic of the definition of food in a little bit.

Method Validation Needs

After the final regulations for Nutrition Labeling in the US were issued by the USDA and the USFDA, the task force reassessed methods adequacy and needs. The updated listings were published in the March and April, 1993 issues of the Referee respectively. In particular, methods and/or collaborative studies are needed for beta-carotene, biotin, sugar alcohols, sugars (verification for certain matrices), cholesterol, copper, cyanocobalamine, defatting of samples for dietary fiber, fat (total, saturated, monounsaturated, and stearic acid), folacin, iodine, niacin (microbiological method), pantothenate, protein (eliminate mercury use), pyridoxine, tryptophan (microbiological method), vitamin A, vitamin C (where erythorbate is present), and vitamin E. As I said before, some of these nutrients do have adequate methods, however, the methods are in need of modernization and therefore are recommended for further study.

All this brings to mind yet another definition for NLEA. Per AOAC, we Need Loyal Enthusiastic Analysts to validate appropriate methods.

Systematic Approach to Method Evaluation-Food Triangle

I would like to return now to a question that arose during the task force deliberations. How does one ascertain with reasonable confidence that a method is applicable to all foods without a substantial history of trouble free application to a wide variety of food samples? Clearly, a defined systematic approach might be helpful to assure method ruggedness across all food types while minimizing the analyst's efforts in assessing the method. The task force Subcommittee on Definition of Foods for Analytical Purposes has proposed an approach that is currently being considered by the Foods committees and the Official Methods Board.

The idea of requiring a collaborative study of forty or more samples can be very discouraging, both for the associate referee organizing the study and for potential participants. There are five macronutrient components of any given food; moisture, ash, protein, fat, and carbohydrate. Moisture of nearly all samples can be adjusted if the level affects an assay. Water can be added, or the sample dried. Ash content of a sample usually has little effect on assays, particularly for organic nutrients. Therefore, the remaining three macronutrients, fat, protein, and carbohydrate have the major impact on the effectiveness of an analytical method. If we picture a triangle with fat, protein, and moisture at the apices, all food samples will fit somewhere on that triangle, assuming the sum of fat, protein, and carbohydrate is normalized to 100%, and these components are expressed as a percentage thereof. For example, a sample with 10% fat, 30% carbohydrate, and 10% protein will have normalized values of 20% fat, 60% carbohydrate, and 20% protein.

The triangle can be split equally in nine subtriangles, with any particular nutrient lying between 0-33%, 33-67%, and 67-100% respectively. By choosing eighteen samples (two from each subtriangle), the analyst would be reasonably certain of covering foods characteristic of most foods. To develop further confidence in a method, samples taken from a subtriangle can be purposefully chosen to represent particular characteristics, i.e. for the 67-100% carbohydrate subsection, a high fiber and a high starch sample might be used. For the 67-100% fat section, a dairy or animal fat and a vegetable fat might be chosen. The system could be applied to any nutrient being analyzed by using a Youden pairing technique for determination of within laboratory variability for the analyte of interest. If difficulty is experienced with getting acceptable results for the method in question for samples from certain subtriangles, this information could be quite helpful for understanding and delineating the cause of the ineffectiveness.

Conclusion

The task force has completed its objectives and reported the results of its deliberations on an ongoing basis in the Referee, the Official organ of AOAC. The final report has been submitted to and accepted by the Official Methods Board and will be published soon in the Journal of AOAC International. The task force disbanded at the July Annual International Meeting of AOAC International.

NEW FOOD INGREDIENTS

Sweeteners
Lyn O'Brien Nabors, *Calorie Control Council*

Fat Replacers, Fat Mimetics, Bulking Agents
Dennis Gordon, *University of Missouri-Columbia*

New Food Ingredients: Sweeteners

Lyn O'Brien Nabors, Calorie Control Council

Thank you. I would like to thank you for inviting me to share with you the latest on alternative sweeteners. I will be discussing both low-calorie sweeteners and sugar alcohols. But first, as mentioned, I work for the Calorie Control Council. The Council has represented the low-calorie food and beverage industry for over 25 years. Today we have over 60 members, including manufacturers of "light" and low-calorie foods and beverages, as well as the manufacturers of alternative sweeteners, fat replacers, and reduced calorie bulking agents. Over the years the Council has addressed sweetener safety; low-calorie benefits issues; numerous labeling issues; and , since 1978, the Council has conducted consumer research on dieting and the use of low-calorie products.

What we now refer to as low-calorie, sugar-free, low-fat and often "light" foods and beverages were originally known as dietetic or "diet" foods. These products were developed for people with diabetes or others with specific medical conditions, including obesity. They were found in health food stores or on obscure shelves in the special dietetic section of the grocery. They were not known for their variety or taste but for their high prices. Today, these products are found in virtually every department of the supermarket, are greatly improved in taste and are priced competitively with comparable full calorie products. As a result, the popularity of low-calorie, low-fat, and "light" products continues to grow, as does the demand.

Light Product Use

Light foods and beverages -- i.e., products with reduced calories, fat or cholesterol -- are more popular than ever. In the United States, according to a 1994 survey conducted for the Calorie Control Council by the Gallup Organization, 90% of U.S. adults consume low-calorie, sugar-free and/or reduced-fat foods and beverages. That projects to 173 million consumers of light products -- a significant increase from the 152 million light consumers we found in our survey just over one year ago.

The 1994 survey revealed a number of important findings. For example, 93% (94 million) American women and 87% (79 million) American men are regular consumers of the low-calorie, sugar-free and/or reduced-fat foods and beverages, which make up the "light" category. Thirty-four percent of light food consumers use light <u>foods</u> every day, while 62% use them several times a week. Thirty-six percent of light <u>beverage</u> consumers use light beverages every day while 49% use them at least several times a week.

The most popular light products in the U.S., according to the survey, are: low-fat milk, reduced-fat butter and margarine, reduced-fat salad dressings and mayonnaise, diet soft drinks, low-fat cheese, and sugar substitutes.

The survey provides strong evidence that American adults are maintaining healthier diets today than in the past. The survey found that 77% of adults agree with this statement: "Overall, I am eating a healthier diet today than three years ago." Additionally, "better health" was the top reported reason why people use light products, following a trend seen in previous Council surveys.

Nearly two-thirds of American adults, about 119 million people say they always try to check the nutrition labels of the foods and beverages they buy. Furthermore, the survey found that 62% said they always try to check the nutrition label to determine the fat content; 57% said they always try to check the calories. Interestingly, the survey found some Americans are engaged in a dietary balancing act --

occasionally indulging in higher calorie foods despite their commitment to healthy eating and use of light products. In fact, half (50%) of Americans say that they choose light foods and beverages so they can enjoy other, higher-calorie foods and beverages while still controlling their total caloric intake.

That's a summary of the current situation relative to light foods in general. Now I'll discuss the Council's survey data particularly on the use of low-calorie, sugar-free foods and beverages -- the products containing the alternative sweeteners I'll discuss in a few moments.

The Calorie Control Council has been specifically tracking the use of low-calorie, sugar-free products since 1978, when 42 million adult Americans consumed low-calorie products. At that time saccharin was the only available low-calorie sweetener in the U.S. marketplace. Since that time, as you know, we have witnessed phenomenal growth in the sugar-free market thanks to the introduction of aspartame and its expanded approvals throughout the 1980s, and then the introduction of products containing acesulfame K in the late 1980s. Between 1991 and 1993 alone the number of consumers of sugar-free foods and beverages increased by 8 million, reaching a total of 109 million people --nearly 3 out of every 5 adult Americans.

Between 1978 and 1986 there was steady growth among both men and women, though the number of female consumers of low-calorie products increased at a slightly faster rate. Since 1986, we have seen further growth among both men and women; however, the highest rate of growth has alternated by sex with each survey. Today, for the first time ever, a majority of adult American men consume low-calorie, sugar-free foods and beverages. In all, 54% of men in the U.S. and 63% of women consume low-calorie products.

By far the most popular low-calorie sugar-free product category is diet soft drinks, consumed by 76% of low-calorie food and beverage consumers and 44% of all adult Americans. Other popular products are sugar substitutes (consumed by 34% of the adult population); sugar-free gum (28%); sugar-free puddings and gelatin (20%); sugar-free yogurt (18%); sugar-free frozen desserts (15%); sugar-free powdered drink mixes (14%); sugar-free cakes and cookies (12%); sugar-free jams and jellies (12%); and sugar-free candy at 11% of the adult population.

Regarding the motivation for using low-calorie, sugar-free products we find that the theme of a healthy lifestyle is dominant. "To stay in better overall health" was clearly the most important reason for using low-calorie products among Americans, as we see in this chart. No longer are sugar-free products for dieters -- indeed, two-thirds of the users of these products are <u>not</u> on a diet.

Now let's look at the ingredients that make low-calorie, sugar-free products possible.

Multiple Sweeteners

For nearly a century, low-calorie products were almost entirely dependent on saccharin, the oldest of the low-calorie sweeteners. Now with the addition of aspartame and acesulfame-K, and possible future approval of sweeteners like cyclamate, alitame and sucralose, a multiple sweetener approach is being utilized -- providing new product and taste choices.

A variety of sweeteners is important because neither sucrose, saccharin, aspartame, acesulfame-K nor any of the new sweeteners is perfect for all uses. But with several available, each sweetener can be used in the applications for which it is best suited. Manufacturers also can overcome limitations of individual sweeteners by using them in blends.

During the 60s, cyclamate and saccharin were blended together in a variety of popular diet soft drinks and other products. This was really the first practical application of the multiple sweetener approach. The primary advantage of the sweetener blend was that saccharin boosted the sweetening power of cyclamate, while cyclamate masked the aftertaste that some people associate with saccharin.

The two sweeteners when combined have a synergistic effect -- that is the sweetness of the combination is greater than the sum of the individual parts. And this is true for most sweetener blends. As you may know, cyclamate was taken off the U.S. market in 1970, leaving saccharin as the only available low-calorie alternative to sugar.

Saccharin

Saccharin, the first low-calorie sweetener, is over 100 years old. Millions of people have relied on it for decades.

Saccharin, 300 times sweeter than sucrose, is a versatile sweetener appropriate for most food, beverage, drug and cosmetic products because it is stable in storage and at its melting point of 228°C; it has an excellent shelf life; combines well with other sweeteners; and is suitable for incorporation in dry and liquid mixtures. Saccharin is non-cariogenic and may help inhibit the development of dental caries. Though a popular sweetener, some people detect an aftertaste in saccharin-sweetened products. This generally can be eliminated by blending saccharin with another sweetener.

Saccharin is used in the United States in soft drinks, most frequently in combination with aspartame in fountain drinks. It remains very popular as a tabletop sweetener.

Although the total amount of saccharin used today is less than in the past, saccharin remains an important, and necessary ingredient for many food, pharmaceutical and cosmetic products. Its safety has been confirmed by numerous scientific groups and regulatory agencies around the world. Saccharin is currently approved for use in over 90 countries.

Aspartame

It wasn't until 1981 that aspartame made its debut in the U.S. food supply. Since then aspartame's approved uses have been expanded considerably. Thousands of products containing aspartame are currently available in over 90 countries. Aspartame -- under the brand NutraSweet -- has been the driving force behind the booming popularity of low-calorie products in the United States. Aspartame, 180 times sweeter than sugar, has a clean sweet taste; enhances and extends flavors, especially fruit flavors; acts synergistically with other sweeteners; and does not promote tooth decay.

Aspartame can be used successfully in both high temperature short time and ultra-high temperature pasteurization systems with minimal loss but it cannot withstand prolonged heating environments such as in baking.

An encapsulated form of aspartame, however, which can withstand oven temperatures, has been approved by FDA and should appear in products soon. The FDA has set an acceptable daily intake (ADI) of 50 mg/kg body weight for aspartame. A 132 lb. person would have to consume 18 cans of soft drink every day to reach this ADI.

Acesulfame-K

In 1988 FDA approved a new low-calorie sweetener, acesulfame-K. It works well in combination with other sweeteners and is 200 times sweeter than sucrose with a clean, quickly perceptible sweet taste that does not linger. Acesulfame-K, a derivative of acetoacetic acid, is not metabolized and is excreted from the body unchanged. Its initial approved uses in the United States include dry beverage mixes, instant coffee and tea, puddings, gelatins, chewing gum, dairy product analogs and tabletop sweeteners. It was recently approved for use in candies. It is currently available under its trade name, Sunette, in the tabletop sweetener, Sweet One, in Trident gum, Bazooka gum, Sweet 'N Low candy, Jell-O and a number of regional products. Soon Acesulfame K is expected to be approved in the U.S. for additional uses, including baked goods. Earlier this month Canada proposed the approval of acesulfame K for a broad range of products including beverages, beverage mixes, tabletop, salad dressings, confectionery and baked products.

Acesulfame-K can be stored in solid form for many years if stored under dry conditions and protected from light. It has excellent stability in aqueous solutions. At pH 3 and above -- the usual pH range of soft drinks -- no reduction in sweetness was observed over several months.

Low-Calorie Sweeteners -- The Next Wave

Sucralose, cyclamate and alitame could be added to FDA's list of approved low-calorie sweeteners.

Sucralose

Sucralose was discovered in 1977. It is being developed in the U.S. by McNeil Specialty Products Company, a division of Johnson & Johnson. In February of 1987, McNeil filed a petition with the Food and Drug Administration for the approval of sucralose in the U.S.

Sucralose is made from common table sugar through a multi-step process. The result is a white crystalline solid which is freely soluble in water as well as ethanol and methanol. Sucralose has a clean, high-quality taste with an average sweetness intensity of about 600 times that of sugar. It is both non-caloric and non-cariogenic and resistant to hydrolysis and breakdown by microorganisms. Sucralose is remarkably stable with an estimated storage life of four years at 20 degrees centigrade. In dry products sucralose has an even longer shelf life.

FDA has been petitioned for the use of sucralose in 14 categories including baked goods; beverages; chewing gum; dairy product analogs; salad dressings; frozen dairy desserts; fruit and water ices; gelatins and puddings; jellies and jams; milk products; and sugar substitutes. -- And approval in the US could come later this year. Sucralose is currently approved for use in Australia, Canada, Mexico and Russia.

Cyclamate

Cyclamate is a sweetener that may be familiar to many of you. We were very pleased that an FDA official was quoted in the Washington Post and other media as saying that the agency made a mistake when it banned cyclamate.

During the 1960s the cyclamate-saccharin combination made some very popular low-calorie products possible. Cyclamate is currently approved in more than 50 countries worldwide, although not in the United States. In late 1982, a petition to FDA for the reapproval of cyclamate was submitted jointly by the Calorie Control Council and Abbott Laboratories. If cyclamate is reapproved, it will be used in combination with other sweeteners for most products -- primarily because of its relatively low sweetness intensity, approximately 30 times that of sucrose.

Cyclamate has a number of technological attributes. It is stable in heat and cold; micro biologically inert; non-hygroscopic; easily soluble in water; compatible with a broad range of foods and food ingredients; and has an extensive shelf life. Approval has been requested for the use of cyclamate in beverages, processed fruits, gelatin desserts, jellies, jams, toppings, salad dressings, chewing gums, confections and as a sugar substitute for cooking or tabletop use.

Cyclamate was the major factor in launching the diet segment of the carbonated beverage industry. By the time it was banned, the products and trademarks had been well established. Such a large market for diet beverages provided a tremendous incentive to develop new sweeteners. We hope that cyclamate will indeed be reapproved in the United States.

Alitame

The third low-calorie sweetener pending FDA approval is alitame. Like aspartame, it is chemically synthesized. Pfizer filed a food additive petition with the U.S. Food and Drug Administration in August 1986. Alitame was recently approved for use in Australia and petitions are currently pending in a number of other countries.

Alitame is a dipeptide based high intensity sweetener formed from the amino acids, L-aspartic and D-alanine, and a novel amine. Alitame is partially caloric, since the aspartic acid portion of the molecule is available for normal amino acid metabolism. The maximum caloric contribution of 1.4 calories per gram of alitame is clearly insignificant at use levels in the diet. Alitame only contributes about 0.02% of the calories of the replaced sucrose, because of its intense sweetness -- 2000 times that of sucrose.

The food additive petition for alitame requests broad clearance for alitame in foods for which standards of identity do not preclude such use. Categories petitioned include; baked goods; presweetened, ready-to-eat cereals; milk products; frozen desserts; fruit drinks; jellies and jams; sweet beverages; and tabletop sweeteners. FDA's review of alitame is continuing.

Alitame is a crystalline, odorless, non-hygroscopic powder. It is synergistic with acesulfame-K and cyclamate and high quality blends may be obtained with these and other sweeteners, including saccharin.

There are a number of other low-calorie sweeteners in various stages of development including some plant derived sweeteners. For example, thaumatin and stevioside, two sweeteners from plants, are currently being used in some parts of the world.

A group of sweeteners which may be of interest to you is the sugar alcohols, or polyols. These sweeteners have been used for many years as alternatives to sucrose because they have desirable technical properties, are non-cariogenic, may be useful in the diets of people with diabetes and, more recently, have been considered as reduced in calories. The polyols generally available for use are isomalt, lactitol, maltitol, mannitol, sorbitol, xylitol, hydrogenated starch hydrolysates (HSH) and hydrogenated glucose syrups, also know as maltitol syrups. They are most frequently used in sugar free candy and gum.

The caloric contribution of the sugar alcohols or polyols is becoming an increasingly important issue. In 1990, the now European Union assigned a caloric value of 2.4 calories per gram to the polyols as a group. Some individual countries such as Switzerland have taken similar action. Other countries have chosen to provide for individual caloric values. In the United States, polyols, as carbohydrates, are generally considered to have 4 calories per gram for labeling purposes. For many years polyols have been used primarily for their non-cariogenic properties rather than as lower calorie bulk sweeteners. However, studies on the absorption and metabolism of polyols have long confirmed that the U.S. "default value" overestimates their true caloric value. As early as 1946 the FDA issued a letter to Atlas Powder Company (now part of ICI Americas Inc.) which stated that the FDA would not object to the use of 2 calories per gram in calculating the caloric value of mannitol when present in foods for special dietary purposes.

In 1992 the Calorie Control Council on behalf of its Polyol Committee contracted with the Federation of American Societies for Experimental Biology, known as FASEB, to evaluate the available data on the metabolizable energy of sugar alcohols, specifically isomalt, lactitol, maltitol, mannitol, sorbitol, xylitol and hydrogenated starch hydrolysates, including maltitol syrup, and to determine or provide best estimates of the metabolizable energy value(s) for the selected polyols. The study scope was later expanded to include both the metabolizable and net energies of sugar alcohols as it is believed, for technical reasons, that the net energy is a better estimate of the true caloric contribution of polyols to foods than is metabolizable energy.

FASEB is completing its report and is expected to conclude that polyols have caloric values less than 4. This report may be used by individual companies or the Calorie Control Council's Polyol Committee as support for a request to FDA to provide for a reduced caloric value or values for the various polyols .

A caloric determination of three or less calories per gram for polyols is especially important to the polyol manufacturers and in turn to the manufacturers of polyol containing products. Under current regulations, reduced calorie foods must have a 25% caloric reduction from their full calorie counterparts and in many polyol containing products the polyol or a combination of polyols provides the principal ingredient. Therefore, with a caloric value of 3 or less the product might be able to make a reduced calorie claim. For example, products sweetened exclusively with polyols or a combination of polyols and low-calorie sweeteners may bear a "sugar-free" claim, however, unless the product is reduced-calorie the label must also state that the food is not a reduced-calorie food. To illustrate the label would read, "sugar-free, not a reduced calorie food." A reduced caloric value or values for polyols might also allow for "light" labeling although this would require a 33 1/3% reduction and is a little more complicated perhaps than using reduced calorie labeling.

Low-calorie sweeteners and the food and beverages they are used in can play an important role as part of an overall healthy diet and lifestyle. It's important to remember, however, that . . . no product is a panacea, and additional reduced-calorie food and beverages will not replace a person's need for moderation and overall good nutrition. However, when incorporated into a nutritionally balanced diet, low-calorie and light foods and beverages can contribute positively to a healthy lifestyle.

In conclusion, as Americans continue to choose healthy eating options, low-calorie, sugar-free products are not chosen just as a part of a healthy lifestyle but also for their taste. The number of consumers who say refreshment or taste is an important reason for consuming low-calorie, sugar-free products has increased significantly over the years. In 1993, 49% of low-calorie, sugar-free consumers said they choose these products for refreshment and taste and over half (56%) of users would like additional low-calorie sugar-free products to be available. And, as additional low-calorie sweeteners become available and the uses of those currently available are expanded, manufacturers can further incorporate the multiple sweetener approach leading to new and better tasting product choices to meet this tremendous consumer demand for sweetness and light.

Fat Substitutes, Fat Mimetics and Bulking Agents

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Introduction

Everyone wants to consume fewer calories. Since excess weight is the principal and common factor associated with heart disease, cancer and high blood pressure, it is understandable why everyone is interested in reducing their caloric intake. Also, many people want to manage their weight for social, economic and other health reasons. Managing one's intake of calories is important! The first item listed on the new food label are calories per serving. Because of this almost general wish to manage one's weight and subsequent desire for fewer calories, the food industry is motivated to develop and market low calorie foods. Low calorie foods sell very well in the marketplace.

The design and manufacture of low calorie foods have required different strategies. These include using less fat and sugars, adding more water or more air and using some old and some new food ingredients. The subject of this review deals with these latter ingredients and they can be classified into two categories, fat replacers and bulking agents. These ingredients help the food manufacturer use less fat, albeit non digestible fat, and less sugar. The ultimate goal is to have fewer calories. Fat replacers can be further divided into two subcategories based on their chemical and physical properties, fat substitutes and fat mimetics. Many reviews on these food components are available.

In the spirit of this conference, it can be asked if these ingredients can be considered nutrients. Secondly, it can be asked if it is appropriate or necessary to have information on their amounts in foods and the food supply. The answer to both question is "yes". However, as will be discussed, these ingredients may best be described as non-conventional nutrients. Often they will be listed on the food label as "ingredients" immediately below the "Nutrition Facts" panel, but their use or function will not be shown. The total purpose of this review is to explain why the two questions starting this paragraph should be answered in the affirmative. Secondly, explain the significance of these ingredients in food systems and their influence on human physiology and potential health.

Possibly the best analogy to use in suggesting how fat substitutes, fat mimetics and primarily bulking agents can be classified as nutrients, would be to compare them with dietary fiber. Dietary fiber is believed to have very positive effects on human nutrition and health. It is required that the amount of dietary fiber in any food be included in the "Nutrition Facts" panel. There are strong recommendations from the nutrition community to increase our current dietary fiber intake form an estimated 11-24 g/day to 25-35 g/day. Complete information is being accumulated on the amount of dietary fiber in foods, to include its distribution into soluble and insoluble components. All this interest and work to inform the consumer about the amount of dietary fiber in their foods, recommendations to eat more, and all for a food component never found to be or classified as a [essential] nutrient! The author is of the strong opinion that dietary fiber should be considered an essential nutrient.

As the reader progresses through this review, the author would like him/her to continually think about the effects of these food ingredients in the intestine. It is through this entire organ that these low calorie ingredients may be exerting their unique and beneficial properties. Once ingested, they are on a unique journey in you and my intestine!

Fat Substitutes

Fat substitutes are similar to fats and can be defined as a compound that replaces triglycerides in cooking or in a food. Typical examples of fat substitutes are sucrose polyesters (i.e., Olestra, Proctor and Gamble Co.) and triglycerides containing specific fatty acids (i.e., Caprenin, Procter and Gamble Co.). Olestra is a mixture of the hexa-, hepta-, and octaesters (> 75%) of sucrose with fatty acids ranging in length from 8 to 22 carbon atoms. These sucrose polyesters cannot be digested in the small intestine and pass directly into the large intestine. Caprenin, a second type of fat substitute, contains caprylic (C8:0), and capric (C10:0) fatty acids in approximately equal amounts randomly esterified to two hydroxyl groups of a glycerol molecule and with behenic acid (C22:0) esterified to the remaining hydroxyl group. The melting point of Caprenin is approximately 32-35^{0}C compared to 80^{0}C for behenic acid. The ester bonds of the two medium-chain fatty acids are easily split with pancreatic lipase, but the ester linkage with behenic acid is not easily hydrolyzed. Any free behenic acid liberated or the monoglyceride containing behenic acid, monobehenen, cannot be liquefied at body temperatures and subsequently cannot be absorbed from the small intestine because of their high melting points. Caprenin is claimed to have 5 kcal/g compared to 9 kcal/g for conventional fats. Compared to sucrose polyesters that enter and leave the large intestine intact, less than one-half of the starting materials in Caprenin reach the large intestine. Other fat substitutes currently under development and safety testing are: esterified propoxylated glycerol; dialkyldihexadecyl malonate; dicarboxylic acid esters; jojoba oil; polysiloxanes; trialkoxycitrate; and trialkoxytricarballylates. These intact or partially digested fat substitutes (i.e., Caprenin) reaching the large intestine are not further acted upon by intestinal microflora.

Of all the fat substitutes available, only Caprenin has had limited application in foods. It was successfully used to reduce the caloric content by 25% in a new generation of Hershey and Milk Way II candy bars. All other fat substitutes still require approval for use from the Food and Drug Administration (FDA).

Fat Mimetics

Fat mimetics can be carbohydrates or proteins and are used to replace fat in foods because of their textural or organoleptic properties. Currently there is approximately 50 carbohydrate based fat mimetics available for use in foods and most can generally be described as modified starches or maltodextrins. Many of the gums or hydrocolloids used in food can also be described as fat mimetics and will be discussed later in this review. Fat mimetics derived from carbohydrates, with a few exceptions, are totally digestible and provide 4 kcal/g. Their usefulness resides in having the properties and mouth feel of fats, but with less caloric density. Because fat mimetics are digested and their repeating monosaccharide subunits are absorbed, these products do not reach the large intestine. Some of the common carbohydrate based fat mimetics are: N-Oil, derived from tapioca; N-Flate, from corn starch and; the N-Lite series of waxy maize maltodextrins. These products are produced by the National Starch and Chemical Corp. N-Flate is a composite material containing modified starch, nonfat milk solids, emulsifiers and guar gum. Others include: Maltrin M040, a corn maltodextrin (Grain Processing Corp., Muscatine, IA); Stellar, made from corn starch (A. E. Staley Co., Decatur, IL); Paselli SA-2, a potato starch product (AVEBE, Foxhol, Holland); and Nutrio P-Fibre, from pea fiber (Danish Sugar Factories, Braband, Denmark). This last product, Nutrio P-Fibre, is an example of a product designed to serve as a fat mimetic, but is nondigestible in the small intestine and will pass into the large intestine. Although listed as a fat mimetic, Nutrio P-Fibre can more accurately be considered as a type and source of dietary fiber.

Other additional carbohydrate based fat mimetics that deserve special mention are resistant starches (various manufactures), Fibersol-2 (Matsutani Chemical Ind. Co., Ltd, Japan) and polydextrose (Pfizer Chem. Co., Groton, CN). Resistant starch can simply be defined as starch resistant to digestion in the small intestine. The discovery of resistant starch in foods and its possible role in intestinal physiological is credited to Drs. John Cummings and Hans Englyst of the Dunn Nutrition Laboratories, Cambridge, United Kingdom. Both resistant starch and Fibersol-2 can be described as non-digestible dextrins, but Fibersol-2 may not be a true resistant starch because of its different chemical and physical properties. Resistant starch is insoluble and Fibersol-2 is soluble in water. Resistant starch is considered to have exclusively (1-4) glycosidic linkages. Different glycosidic linkages between glucose units are reported to be present in Fibersol-2. These compounds are not completely digested in the small intestine and a majority pass into the large intestine. During the heat processing of starch, especially high amylose starch, partial retrogradation occurs causing the resulting retrograded starch to have limited or resistant digestibility in the small intestine. Resistant starch is considered quantitatively fermented in the large intestine. Resistant starch products will vary depending on the starting material and processing conditions used to retrograde the starch. Besides the potential of adding resistant starch to foods as a food ingredient or fat replacer, it is estimated that conventional food processes contribute 10-30 grams of resistant starch to the diet per day and ultimately the large intestine. Crystalean (Opta Food Ingredients, Inc. Cambridge, MA) is a commercial resistant starch undergoing further development. Fibersol-2 can also be described as a product undergoing further development and testing. Polydextrose or Litesse (Pfizer Chem Co., Groton, CN) is a synthetic polymer consisting primarily of cross-linked glucose molecules and smaller amounts of sorbitol and citric acid. The molecular weight of the polydextrose polymer averages 1,500 and is water soluble. Because of its solubility, polydextrose is classified and used as a bulking agent. Only 25% of polydextrose is digested and therefore provides only one kcal per gram. There remains debate if it should be classified as a source of dietary fiber.

Protein based fat mimetics are not as many as the carbohydrate based fat mimetics, but they have received considerably more attention in the media. Their use in foods is based on their extremely small size, ranging from 0.1 to 3.0 μ (microns), and spherical shape. These two properties combine to result in smooth flowing layers of these particles mimicking the texture and mouth feel of fat. This textural property can be described as ball bearings rolling over each other. Three recently developed protein based fat mimetics are: Simplesse (The NutraSweet Co. Deerfield, IL) made from milk proteins and egg white; Trailblazer (Kraft-General Foods, Glenview, IL) derived from egg white, whey protein and xanthan gum; and LITA produced from corn zein (Opta Food Ingredients, Inc., Cambridge, MA). Because protein based fat mimetics are considered completely digested, very little reaches the large intestine. The xanthan gum in the Trailblazer product would be a non-digestible component, but the amount contained therein can be considered insignificant. The caloric content of Simplesse, Trailblazer and LITA are all 4 kcal/g.

Gums--Hydrocolloids

In discussing the use of fat mimetics in the design and manufacture of low calorie foods, it must be mentioned that many of these food ingredients do not function well unless used with gums (hydrocolloids). Gums are defined as non-digestible homo- and hetro-polysaccharides extracted from land and marine plants and microorganisms. Also, to be included in this category are the synthetic and modified edible polymers used for their hydrocolloid properties in foods. Martin Glicksman, formally with the General Foods Corp., has made continuous contributions in defining the chemistry and functionality of gums in food systems. There are many gums available for use in foods as fat replacers and these have been extensively reviewed by Mr. Glicksman. More correctly defined as hydrocolloids based on their functional properties in foods, these non-digestible carbohydrate polymers have made a recent reincarnation as soluble dietary fibers. Irrespective of the term used to describe these compounds, gums, hydrocolloids or soluble dietary fiber, they are extensively used with fat replacers or by themselves in foods. The important point to mention about gums is that they are not digested in the small intestine, but degraded to varying degrees by bacteria in the large intestine. Since gums are such as integral part of foods, and especially processed foods, they can play an important role in the in the general dynamics of the large intestine.

Bulking Agents

With the extensive use of high intensity sweeteners in foods (i.e., NutraSweet-aspartame, saccharin, and Acesulfame K), there is a need for non-caloric bulking agents. These bulking agents will provide for the body and texture in a food normally contributed by sugar. To accomplish their intended purpose of providing bulk without calories, bulking agents are non-digestible and non-absorbable and therefore pass into the large intestine. The ideal bulking agent would be as sweet as sugar and provide no calories, a model that currently does not exist! Polydextrose, previously mentioned, is the most widely used bulking agent in foods today. Other bulking agents that appear to have applicability in foods are briefly described. Isomalt or Palatinit (Palatinit USA, Elkhart, IN) consists of an approximately equal mixture of D-glucopyranosyl 1,6-mannitol and D-glucopyranosyl 1,6-sorbitol. Isomalt is reported to have 40-60 % of the sweetness of sucrose and is claimed to have one-half the calories. Raftiline (Tiense Suikerraffinaderij, Belgium) is derived from inulin and the oligofructan polymers can contain up to 60 fructose molecules (60 DP, degree of polymerization). Raftilose, also an oligofructose, is a mixture of glucofructosan and fructosan polymers containing two to nine sugar molecules (2-9 DP) and can be best described as the enzymatic hydrolysis products of raftiline or inulin. The caloric contents of Raftiline and Raftilose are reported to be 1.0 kcal/g and 1.5 kcal/g, respectively. Chemically and structurally similar to Raftilose are fructooligosaccharides or Neosugars. Fructooligosaccharides are naturally occurring in fruits, vegetables and grains and can be described as sucrose molecules to which have been added one (1-ketose), two (nystose) or three (1-ß-fructofuranosyl; nystose) fructose molecules linked in sequence. Each individual unit of fructooligosaccharide will contain a terminal glucose unit. Only a limited number of Raftiline or Raftilose subunits contain glucose at a terminal end of the molecule. Historically, Neosugars have been produced with the aid of microorganisms in limited quantities. With developments in genetic engineering, larger yields can now be obtained. ZeaGen, a subsidiary of Adolph Coors Co. (Broomfield, CO), produces and markets a fructooligosaccharide under the trade name Nutriflora. Fructooligosaccharides have about one-half the sweetness of sucrose and are claimed to have 1.5 kcal/g. Other potential bulking agents include the L-isomers of glucose, sucrose, gulose and rhamnose. Most ingested bulking agents will reach the large intestine.

Also, to be included in the category of bulking agents are small molecular weight compounds or oligosaccharides obtained from the hydrolysis of conventional plant or seaweed gums. Examples of this subclass of bulking agents are hydrolyzed guar gum (i.e., Sunfiber or Benefiber, Sandoz Nutrition Corp., Minneapolis, MN) and hydrolyzed carrageenan called policarren. Carrageenan, not hydrolyzed, has been used as the successful fat replacer in fat reduced hamburgers, although it was used as a fat-water-protein binder and not as a bulking agent. The potential to derive many bulking agents through the hydrolysis of plant and seaweed gums, and pectin, is unlimited. However, it is important to mention that hydrolyzed gums are currently not allowed as food additives by the FDA. Use of these hydrolyzed products may be limited because of the high costs to obtain generally recognized as safe (GRAS) status or approval as a food additive.

Dietary Fiber

Before going further, it is important to mention that dietary fiber is the classical non-digestible food ingredient reaching the large intestine. Dietary fiber has long been described as a bulking agent for use in foods, primarily to lower caloric content. The dietary fiber hypothesis implies that a high intake of foods rich in dietary fiber is associated with the lower incidence of many diseases, notably, chronic bowel diseases, diabetes, coronary heart disease and various types of cancers. By definition, dietary fiber is the remnants of plant cell wall material resistant to digestion by animals and humans. This includes: cellulose, hemicelluloses, pectins, gums and mucilages. Dietary fibers and bulking agents have some similar chemical and physical properties (i.e., solubility and carbohydrate composition) and all could result in similar physiological actions within the body.

Non-digestible Food Ingredients

When summing the total amount of potential fat substitutes and bulking agents to the non-digestible materials (i.e., dietary fiber, mucins, etc.) normally in the human diet, there can be a significant increase for non-fermentable and fermentable solids reaching the large intestine. The cumulative effects of these non-digestible fat substitutes, bulking agents and dietary fiber residues reaching the large intestine can represent a fascinating series of biochemical and physiological events. These widely varied and dynamic events are believed to have a major influence on functioning of the large intestine and ultimately the nutrition and health of this organ and the entire body.

The Large Intestine

For use in foods, we have three classes of compounds that can be used to help reduce caloric content. Having consumed these ingredients in different products, their importance now is to their influence on the body. In summary, fat replacers and bulking agents can be divided into three categories based on their potential reaction in the large intestine: 1) fat substitutes that are not further degraded nor used by the body or intestinal microflora and passed in the stool; 2) small molecular weight carbohydrate compounds (i.e., polydextrose) which are not completely fermented by the microflora and are passed in the stool and; 3) all other classes of carbohydrate compounds acted upon totally or partially by the intestinal microflora. This last group includes all dietary fibers, gums, bulking agents and similar compounds (i.e., polyols, lactose and glycoproteins) in foods and those produced throughout the alimentary tract.

Fat Substitutes

Since the fat substitutes are not degraded by bacteria in the colon, they retain their physical properties. Excess fat substitutes contribute an oily texture to fecal wastes and result in the problem of anal leakage or uncharacteristic oily stool composition. Now, this problem continues to plague fat substitutes from receiving FDA approval as food additives. The ultimate effects of fat substitutes on colonic functioning, their safety and interaction in the milieu of the large intestine are unknown and remain a challenging area for future research.

Carbohydrates

The second category of compounds reaching the large intestine are carbohydrates that will not be degraded or fermented to any further appreciable degree. These small molecular weight soluble compounds, such as polydextrose, will exert a bulking effect helping to retain additional water in the colon based on water-solute osmotic pressure equilibrium. The exact amount of polydextrose digestion occurring in the small intestine and/or fermentation in the large intestine is not known. It is not clearly known what other physiological effects this class of compounds can exert in and on the colon.

Dietary Fiber

Dietary fiber is substantially degraded in the colon, but its degradation is variable. Estimates as to the percent degradation of dietary fiber components are: 30-50% cellulose; 30-80% hemicelluloses; 85% pectins; 75% guar gum; 15% locust bean gum; and 10% carrageenan. The final remnants of soluble and insoluble dietary fiber components passed in the stool help retain water. The non-fermentable, non-soluble dietary fiber residues also serve as an anchor for bacteria in the colon. Stool frequency and ease of bowel movements and avoidance of constipation, are considered some of the most important physiological attributes of dietary fiber resulting from not being degraded. This attribute could also be extended to fat substitutes and bulking agents.

Fermentable Compounds

Having considered the food ingredients and the remnants of food not digested in the small intestine and not further degraded in the large intestine, what remains? The remaining food ingredients and compounds are those providing nutrients and energy for the intestinal microflora. This is a very large and diverse mixture of compounds. With appropriate substrates, the amount and types of microflora populating the large intestine can be dramatically changed. These changes in microflora can cause a cascade of events effecting: 1) the amount and types of enzymatic activity produced by these organisms; 2) the chemical composition of the colon's contents; and 3) changes in morphology of the intestine and the cytokinetics of intestinal cells.

Colonic Fermentation

With increased fermentation, comes increased production of short chain fatty acids (SCFA), hydrogen, methane and carbon dioxide and a fall in colonic pH. Bacteria are induced to use the gases as important sources of energy. These bacteria can be divided into two groups: 1) sulfur bacteria producing hydrogen sulfide and; 2) acetogenic bacteria that reduce both hydrogen and carbon dioxide to produce acetic acid. Increased fermentation lowers colonic pH. This physiological change is desirable. Lower pH in the ascending or right colon has been associated with a lower incidence of colon cancer. The high acid environment also promotes the growth of *lactobacillus* and *bifidobacterium* organisms, excluding the gram negative toxin-producing organisms. Thus, a beneficial relationship occurs. Colonic ammonia concentrations are also reduced, and this is considered advantageous because excess ammonia has been reported to increase cell turnover, especially in malignant cells.

Short Chain Fatty Acids

The three primary SCFA produced by fermentation in the large intestine are acetic, propionic and butyric. Acetic acid, produced through fermentation or through reduction of hydrogen with carbon dioxide by acetogenic bacteria, is used as an energy source by bacteria. This results in increased growth and metabolism. The anaerobic cycle is enhanced. Propionic acid is absorbed from the colon into the circulatory system and transported to the liver. The contribution of propionic acid to the intestinal microflora is not totally understood. Butyric acid is utilized by the colonic epithelial cells and has been implicated to be a potent cell regulator that exhibits antineoplastic activity. The incidence of colon cancer is retarded or reduced.

Intestinal Morphology and Cytokinetics

Food ingredients reaching the large intestine cause dynamic changes within this organ. Of these effects, possibly the most important are changes to the morphology and cytokinetics of the intestine. Morphology refers to the structural and physical characteristics of the intestine and the single layer of cells that line the intestine. Cytokinetics relates to the functioning and related aspects of the individual mucosal cell to include the rate at which cells migrate and are sloughed off the intestine, and the biological cycle that these cells undergo during replication and protein synthesis.

Current information suggests that dietary fiber, especially wheat bran, depresses total DNA and the rate of its replication within the intestinal mucosal cells. The synthesis of DNA and formation of new cells occurs within the cell cycle having 4 discrete phases. These phases are: M-phase or mitosis (cell division); G_0G_1-phase (resting); S-phase (DNA replication) and; G_2-phase (resting). The magnitude of the S-phase of the intestinal mucosal cell provides a quantitative measurement of cellular activity. By using bio-markers incorporated into the DNA and quantifying the number of cells that incorporate the bio-marker compared to the total number of crypt cells, an epithelial cell labeling index can be determined. This parameter is higher in individuals with colon or rectal cancers compared to normal subjects. It can only be speculated how certain dietary fibers and bulking agents can affect the intestinal cell's ability to be in S-phase and for how long a period. The more time cells spend in S-phase, the more time they spend in DNA replication and the greater the opportunity for a carcinogen to effect DNA replication and mutagenesis. It can only be speculated how changes to the diet will affect intestinal functioning and regulation. These answers will come with future research.

Conclusion

Although abstinence to excess food intake is possibly the best therapy for caloric restriction, it is difficult to practice. Low calorie foods produced with the aid of fat replacers and bulking agents offer the possibility to "have our cake and eat it too." It will be important for everyone associated with foods and the food industry to be aware of the functionality of fat replacers and bulking agents and the physiological changes they can produce in the intestine. As dietary fiber must still be proven to be a nutrient and shown to be "essential", similar research must be accomplished to understand the significance of these low calorie food ingredients in human bodily functioning and health. If for example, many different fat substitutes are approved for use in foods and food processing, data bank information will be important, so that individually or collectively, the amounts of these ingredients in the food supply can be determined.

Selected References

References, table and figures about the contents of this article can be obtained from the author. Portions of this article are contained in a manuscript submitted to the Institute of Food Technologist for publication *in Food Technology*.

PERSPECTIVES ON DATA QUALITY

GAO's Recommendations for Improving Handbook 8

Betty Perloff, *U. S. Department of Agriculture,*
Agricultural Research Service-Human Nutrition Information Service

Sources of Errors and Variation in Nutrient Intake Estimates:

Intake Data Collection and Processing

Helen Wright, *Pennsylvania State University*

Food Composition

Gary Beecher, *U. S. Department of Agriculture,*
Agricultural Research Service

Adjusting for Intra-Individual Variability when Estimating Nutrient Intakes

Patricia Guenther, *U. S. Department of Agriculture,*
Agricultural Research Service-Human Nutrition Information Service

Perspectives on Data Quality - Panel Discussion

Lori Borrud, *U. S. Department of Agriculture,*
Agricultural Research Service-Human Nutrition Information Service
Margaret McDowell, *Centers for Disease Control,*
National Center for Health Statistics
Marilyn Buzzard, *University of Minnesota*
Phyllis Stumbo, *University of Iowa*
Sue McPherson, *University of Texas*

GAO's Recommendations for Improving Handbook 8

Betty Perloff, USDA-ARS-HNIS

In October 1993 the General Accounting Off ice (GAO) issued a report entitled "Better Guidance Needed to Improve Reliability of USDA's Food Composition Data." This report was the result of a study during which GAO examined the procedures for producing Agriculture Handbook No. 8 (AH-8), and it includes recommendations for improving the reliability of values published in the Handbook. Evaluations of this type are an important part of government operations, and the Human Nutrition Information Service (HNIS) welcomed the opportunity for an independent and systematic review of its procedures. We are preparing now to implement their recommendations within our budgetary constraints. The purpose of this presentation is, first, to inform our data users about the recommendations and our plans for implementation, and, second, to discuss implications for future food composition data bases.

Full implementation of GAO's recommendations would be very costly and would require either a large increase in resources for generating food composition data or a decrease in the amount of data released by HNIS. If adequate resources cannot be found to fully implement the recommendations, we need input from data users to help us decide how strictly the GAO recommendations should be followed. Since a major use of these data is to estimate nutrient intakes, we believe it is important to look at the quality of food composition data in the context of the quality of other parts of the measurement system for determining those intakes. Therefore, we hope this session, "Perspectives on Data Quality," will help set the stage for users of our food composition data to begin to let us know their views of how the government should balance the competing needs of quantity versus quality for food composition data.

GAO's first recommendation is--

> Develop specific quality assurance criteria for HNIS to use in evaluating food composition data obtained from others before the data are included in Handbook 8.

This recommendation was based on a review of the amount and types of documentation that were available for the information published in the 1991 supplement to AH-8. That supplement was the most recently available Handbook 8 publication at the time of their evaluation. They looked for five specific quality assurance measures.

Before discussing those measures, I would like to point out that this recommendation relates only to data obtained from sources outside HNIS, namely the food industry and the scientific literature, since it was for those data that GAO found some of the documentation lacking. Data generated under HNIS's control, i.e., under contracts with analytical laboratories, were completely documented to GAO's satisfaction. I would also like to point out that all values have received an internal evaluation at HNIS, regardless of the amount of documentation that was received and reviewed, and I will return to this topic after a discussion about GAO's specified quality assurance measures. Each of the measures is discussed below.

1. Number of samples analyzed in developing the data. The guidelines which were established in the 1970's for revising AH-8 required that not only the number of samples be known for each value that was used but also that the standard deviation be included if the number of samples was greater than one. This general guideline still exists but is overridden from time to time under special circumstances, which I will explain later. Full implementation of GAO's recommendation would not allow exceptions.

   Furthermore, GAO recommends that values in AH-8 be based on a minimum of six samples per food item. Presently, there is no minimum requirement; however, we do try to obtain values for as many samples as possible.

   For our contracts, we designate two or three samples, with cost being an important determinant in the final decision. Analysis of one sample for the full set of nutrients currently reported in AH-8 costs approximately $2,000. Imposing the requirement of six samples for each food, at $2,000 a sample, means that analysis of each food would cost approximately $12,000. Based on the funds we have had available for analyses over the past few years, requiring six samples of each food item would have allowed us to analyze about 17 foods a year. This is approximately one-third of the number we have chosen to analyze using fewer samples. However, for this fiscal year this is a moot point, since budget cuts for HNIS have eliminated the funds normally available for food composition analyses.

   Because of limited funds, it is especially critical that careful priorities are set for food analyses. We use data from the Continuing Survey of Food Intakes by Individuals to identify major contributors of various nutrients. Those major nutrient contributors with the weakest analytical base then receive the greatest priority for analysis.

2. Method of sample selection. This item includes factors such as individual versus composite sample; the numbers of individual samples, lots, plants, or brands included in a composite sample; the origin of the food; date of harvest or production; and sampling location. This item was also addressed in the original guidelines for revising AH-8. Currently, information concerning these various factors may be recorded about a nutrient value when it is entered into the Nutrient Data Bank System. However, the nutrient value is not rejected if the information is unknown. Although any experimental samples, or samples not representative of foods currently available, would be excluded.

3. Protection and treatment of the sample prior to analysis. This item refers to how the sample is handled at each stage from harvest or production through analysis at the laboratory. It involves conditions such as environment, temperature, time, treatment, lighting, and packaging. It also includes the type of homogenization that takes place prior to analysis. Again, the guidelines address these issues but do not absolutely require rejection of a value if they are unknown.

4. Method of analysis. Information about analytical methods are required before data can be entered into the data bank system for use in AH-8. In fact, a considerable amount of detail about methods is required. Again, exceptions are made under special circumstances, as explained later.

5. Laboratory procedures used to ensure accurate analytical results. Use of reference materials and other procedures to ensure accurate results are extremely important. HNIS has supported development of reference materials and is very careful about requiring stringent quality control procedures for any HNIS-sponsored analyses. However, most official methods do not specify quality control procedures, and standard reference materials currently are not available for all nutrients. Evidence of procedures

used to ensure accurate analytical results are almost never available for data from sources outside HNIS, and data are not rejected for lack of this documentation alone.

As I mentioned before, GAO examined the documentation for data published in the 1991 supplement to AH-8. The supplement is an annual update and includes pages to be added to the handbook as well as replacement pages where newer values need to supercede previously published values. The number of quality assurance factors they found in the documentation of each data source is listed below.

Number of quality assurance measures in documentation	Number of data sources with documentation
5	10
4	14
3	6
2	3
1	8
0	7
Total	48

As you can see, only 10 out of 48 items included documentation for all five quality assurance measures. The information in this table may be interpreted in two ways. It could be viewed (1) that HNIS was lax in not obtaining the needed documentation for the other 38 items, or (2) that full implementation of GAO's recommendation prior to 1991 would have eliminated approximately 80 percent of the data used for the 1991 supplement. When making your interpretation, please keep in mind that a number of competing factors complicate the development of food composition tables: (a) the need to ensure the best possible values; (b) the need to publish complete nutrient profiles for each food to prevent resesearchers from having to estimate missing values, (c) the expense of obtaining analytical data, and (d) the fact that the contribution of data to the National Nutrient Data Bank by the food industry is strictly voluntary.

We rely upon the goodwill of the food industry for most of the data in AH-8. However, there are no legal requirements that anyone provide data to HNIS. When data are supplied by the food industry, we seldom receive complete documentation regardless of the number of times we request it. It is a burden that most companies are not able, or willing, to bear. When data and documentation are requested, we receive a range of responses, of which some examples are provided below:

1. Analytical data with mean, number of samples, standard deviation, references for methods of analysis, and descriptions of quality control procedures for most of the nutrients.

2. Analytical data with no indication of variability. We may or may not be able to obtain references for methods of analysis for some of the nutrients.

3. Values for most of the food components in AH-8 but no indication if values are analytical or calculated.

4. Label claim data as the percentage of U.S. RDA per serving for only those nutrients required for nutrition labeling.

5. No response.

Our original guidelines for accepting data from outside sources for AH-8 would not have allowed us to accept values falling into the second, third, or fourth category above. We relaxed our requirements to include values from the second category under certain circumstances. Specifically, we believe that analytical data which were generated and were used for the purpose of preparing nutrition labels should be included in AH-8 if (1) data with better documentation are not available and (2) the data have passed an internal evaluation. In fact, all values receive the same evaluation before they are used regardless of the amount of documentation that is received. This includes a comparison to existing values for the same or a similar food item. The amount of variance expected differs for different types of foods, but in general we expect no more than 5-10 percent variance for proximates and 10-20 percent for vitamins and minerals. Acceptability of values with larger than expected variances are decided on a case by case basis.

The GAO cited an example of how HNIS had used data from fast food companies for bacon cheeseburgers even though little supporting documentation was received. About the only information we knew was that the data were analytical. For the review of those items, we constructed recipes based on information about the components of the bacon cheeseburgers and calculated nutrient profiles from our Standard Reference Data Base to use for comparison. The calculations were provided to GAO as documentation of our internal review of the items.

Figure 1 provides a frame of reference for the amount of data that is available with complete documentation. Approximately 85 percent of the data in the National Nutrient Data Bank are from sources outside HNIS, namely the food industry and the scientific literature. Very few of those data, about 10-15 percent, are completely documented according to GAO's recommendations. More than half of those data are documented for at least three of the five GAO recommended quality assurance measures.

As you can see 100 percent of data generated by HNIS contracts include all five quality assurance measures, and as I mentioned earlier those analyses cover foods considered major sources of nutrients. The determination of which foods are major sources of nutrients takes into account not only the amount of nutrient in a food but also the consumption level of the food.

One of the reasons we have chosen to use data with less than 100 percent documentation and with limited numbers of samples has come from our participation in this conference over the years. We have been convinced that it is better for USDA to provide data with limitations than for each researcher to have to derive missing values. In view of the GAO findings and our own belief that the situation with food composition data does need to be improved, we would like to revisit, with you, your requirements for the quality of food composition data as we take steps to respond to the GAO recommendations.

First, we have increased our efforts to obtain additional documentation from our traditional data sources. While the publication of the GAO report has helped focus attention on the need for better documentation, so far the increase in documentation that we have received is negligible. Food companies have been overwhelmed with trying to respond to new nutrition labeling requirements and can find little sympathy for the government's problems regarding quality of food composition data in AH-8. It only stands to reason that the food industry as a whole is not prepared to supply the government with additional information when we can offer no incentive. We will continue to address this issue with food companies.

Second, we are preparing specific data evaluation criteria which cover the GAO recommendations. As you can see from the chart on sources and documentation, unless a considerable amount of resources can be found to fund more analyses, strict adherence to the criteria will eliminate more than half of the data that are now used. Some type of compromise, such as a scoring system, may have to be implemented.

Models for scoring systems have previously been developed for a limited number of nutrients by our colleagues at USDA's Food composition Laboratory (FCL). We hope that they will be able to assist in the development of a more complex model, involving multiple nutrients, which could be built into the structure of a larger data base management environment. In fact, we believe a significant step was made in that direction earlier this month when Dr. Wayne Wolf, a prominent member of FCL, was detailed as Acting Chief of the Nutrient Data Research Branch.

The release of the GAO report was very timely because we were in the process of planning a redesign of our Nutrient Data Bank system. In fact, last year we had decided to extend the planning phase on advice of our Federal Data Bank Users Group. At the time GAO released its report, Dr. Loretta Hoover, a nutrient data base specialist from the University of Missouri, was working with us at USDA to define the specific areas that needed change or improvement. The whole area of data quality and how to record specific infomation for making quality determinations is a part of the redesign effort. We had already planned for a much more extensive set of codes than is presently used to indicate specifics about the derivation of nutrient values. Dr. Hoover was able to identify where documentation requirements might be affected by new evaluation criteria based on GAO's recommendations. We have also been working with Dr. Philip Kott, research statistician with the National Agricultural Statistics Service, who is making recommendations for statistical requirements for the new system.

GAO's second recommendation is--

> Develop procedures to better direct the generation of food composition data under HNIS' contracts.

As mentioned before, data generated under HNIS contracts meet all five of the GAO's recommended quality assurance measures. In fact, HNIS has a very stringent quality assurance program. Contractors must successfully demonstrate their ability to analyze samples accurately before any contract is approved. Also, during a contract they are periodically sent additional samples to check their work. In response to this particular recommendation, HNIS will expand its quality assurance procedures to disguise control samples and to make regular on-site visits to the laboratories.

In closing, decisive public debate regarding food composition research has been lacking for too long. While any criticism is painful, the recent GAO report has helped to focus attention on the requirements for a high quality food composition data base. However, the responsibility for adequate and reliable food composition data extends beyond the compilers of the data. Before we will ever be able to generate adequate amounts of reliable data, we need a policy that sets as priority the development of (1) standard reference materials for all nutrients and (2) official methods that are not only less expensive than current methods but also require the use of appropriate quality control procedures.

We also need public policy that provides an incentive to the food industry to contribute data to the National Nutrient Data Bank. In addition, we need to consider the development of what many other industrialized nations have--a government laboratory whose primary mission is to provide food composition data for the country's food supply.

Finally, HNIS wants to ensure that the needs of data users are fully understood and considered. We welcome your input and we look forward to working with you and other data users to develop a consensus on how best to meet data quantity and quality requirements.

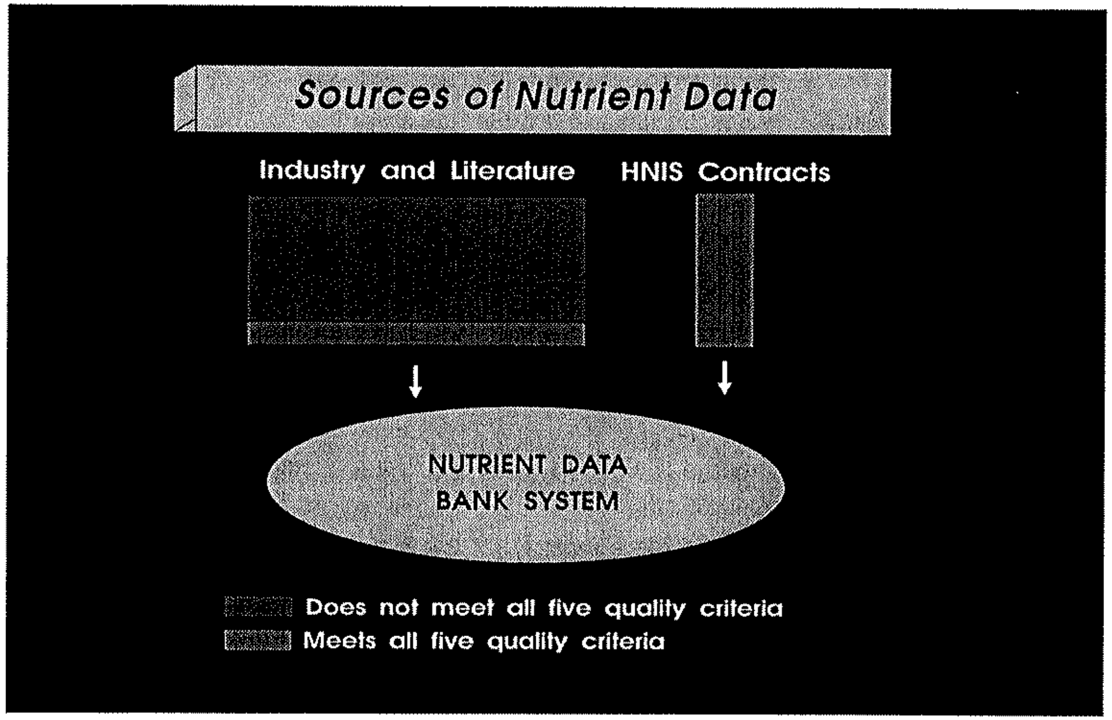
Sources of Nutrient Data
Industry and Literature
HNIS Contracts
NUTRIENT DATA
BANK SYSTEM
Does not meet all five quality criteria
Meets all five quality criteria

Fig. 1

Dietary Intake: Data Collection and Processing

Helen Smiciklas-Wright, Pennsylvania State University

When George Beaton spoke at the First International Conference on Dietary Assessment Methods he began by saying, "In the past decade there has been a great deal published about the errors in dietary data... this is understandable but unfortunate because it can easily leave the impression that dietary data are worthless" (Beaton, 1994, page 2535). He reminded us that dietary intake cannot, and never will be estimated without error; he contended, however, that a serious limitation is not the errors themselves but failure to understand the nature of the errors and their impact on specific strategies of data analysis.

Many publications in recent years have reviewed dietary methodology and the error structures associated with different methods (LSRO, 1986; Bingham, 1987; Dwyer, 1988; Pao et al. 1989). Sheila Bingham (1987) described nine potential sources of error ranging from sampling bias to food tables. The list includes errors that are consequent to the information that clients/subjects provide about their food intake (i.e. weights or portions of foods, recall and reporting of food items, frequency of consumption) and the errors associated with data processing (e.g. coding).

Unquestionably, as Beaton noted there has been criticism about the quality of dietary data with much of the criticism centered on the accuracy of self-reported dietary data. Several recent reports have focused on the relation between self-reported energy intake and intake determined to maintain body weight (Mertz et al. 1991) or energy expenditure measured by the doubly- labelled water method (Schoeller, 1990). The work of Mertz and his colleagues which indicated that, on the average self-reported estimates of energy intake were about 20% less than amounts needed to maintain body weight, received considerable attention in the professional and lay press.

Before we consider some factors that may contribute to errors in self-reported data, let me share a quote that I find useful in putting the issue into perspective. It is taken from a paper that appeared in the 1984 Annual Review of Anthropology and states, "Surely our informants are not to blame for being inaccurate. It is not even their problem. People everywhere get along quite well without being able to dredge up accurately the sort of information that scientists ask them for". (Bernard et al., 1984, page 613). In that regard we should be impressed that some people do as well as they do in providing dietary information (Mertz et al., 1991).

<u>Memory</u>. Most self-reported/recalled data depends on memory; we have gained understanding about memory and dietary recall from cognition research which describes memory as the combination of the encoding and storage of information as well as its retrieval.

Encoding is the consequence of several events, beginning with sensory memory in which information is initially registered before being sent to short-term memory (10-20 seconds) and transmitted to long-term memory (Schaie and Willis, 1986). How the information is encoded and how deeply it is processed impacts on subsequent retrieval. The methods for retrieval include free recall, cued recall and recognition. Free recall is the most demanding process involving active searching of memory to locate information, In cued recall active memory searching is guided by cues or clues to where information is stored. Recognition, or matching of information with what is already stored, involves minimal search.

Several examples from the nutrition literature illustrate the applicability of these issues to dietary recalls. An example of free recall was presented in a paper that Helen Guthrie published in 1984 (Guthrie, 1984). She invited young adults to participated in a free breakfast or lunch, to select foods from a buffet and immediately after the meals describe what foods they ate and the amounts. About one-half of those who had milk as a beverage at breakfast failed to mention it; more than one-half forgot sugar added to cereal and about 20% forgot salad dressing. Another example is Campbell and Dodd's (1969) early work which demonstrated the difference between cued recall and recognition when they interviewed younger and older subjects, institutionalized predominantly for tuberculosis. The subjects were asked to recall food eaten in the previous 24 hours. Then the interviewers probed for additional information using a printed menu of the foods served during the post 24 hours. The recognition task or probe added substantially to estimated nutrient intake, more so for older than younger adults suggesting that the 24-hour recall elicited less accurate information from older persons.

Bethene Ervin (1993) recently tested the memory model in order to determine whether findings based on typical cognition experiments apply to a performed activity like eating. She worked with older adults who were served a dinner meal and asked to recall intake 24 hours later. She reasoned that the least accurate recall should occur if there was no intervention encoding and if retrieval was by free call (see Figure 1); the most accurate should occur if encoding occurred with deeper processing and retrieval was by way of recognition. Subjects in the deeper processing treatment group were asked to estimate the serving sizes of foods served to them before they began to eat. In the recognition task, the foods that were served at the meal were embedded in a longer list of foods. The data supported the hypothesized results with the best recall of items occurring with deeper processing and recognition and the least with no intervention at encoding followed by free recall.

Many factors can contribute to incomplete and distorted memory including attention to the event, personal encoding and retrieval strategies, as well as mood status at both encoding and retrieval (Dwyer et al., 1987). Nutritionists have developed and improved strategies for retrieval of information. These strategies include multiple pass methods for 24-hour recalls and structured systems for probing such as those used in the Minnesota Nutrition Data System (Freskonich et al., 1988).

We have paid less attention to strategies that might affect deeper processing. Recently, Chianetta and Head (1992) reported that there was some improvement of dietary recall when older adults received prior notification of the interview.

Portion Size. There is a growing literature on the errors associated with the estimation of amounts or portions of foods consumed. Many papers have reported results similar to Guthrie's previously cited study (Guthrie, 1984) in which young adults were asked to estimate portion sizes after a breakfast or lunch. No portion size aids were provided. There was considerable variables by food in the accuracy of estimations. The percentages of people who estimated within 25% of actual serving size varied from 73% and 68% for orange juice and milk to 13% for salad dressing and 8% for butter on toast. While deviations of 25% or more seem to be large, more accurate estimations would demand subtle distinctions by participants. Several studies that we have conducted recently as part of the USDA Northeast Regional Study on diet assessment persuade us that those are difficult distinctions to make.

We have recently conducted studies with younger and older adults in which they were presented with pairs of food items with some pairs containing the same amounts and some containing different amounts of the foods. There are variable abilities among respondents and by food in detecting whether food portions are the same or different. Data for young adults are shown. (see Table 1).

Ervin's work has added to our understanding that there is a memory component to portion size as well as to item recall (Ervin, 1993). She introduced a portion size memory test in her work with older adults who were served a dinner and asked to recall dietary intake 24-hours later. At the time of the recall they were shown three different portion size of foods served at the meal. For each food one of the portion sizes shown was the same as that which was served. Memory for the "correct" portion size varied (see Figure 2).

A number of portion size estimation aids are used in dietary assessment including the two-dimensional food portion charts developed by Posner et al. Posner et al. (1992) reported recently that mean energy and nutrient intake were similar when the two-dimensional models or equivalent three-dimensional models were used in 24-hour recalls. We are currently doing some work in association with the NHLBI funded Diet Effects on Lipids and Thrombogenic Activity (DELTA) Study in which we are comparing self-reported food intakes using the two-dimensional models and known intakes of clinical trial participants.

Frequency of consumption. Issues of memory and portion size estimations are relevant to food frequencies questionnaires (FFQs) as are frequency of consumption data. The work of Flegal and her colleagues (Flegal et al.) 1988) is one approach to understanding the source of errors in FFQs. They used 16 days of food records completed by adults and converted the data into a 116-category food frequency format. They compared the "created" FFQ with their participants' responses on an actual FFQ. Their analyses partitioned for the sources of difference between the two FFQs. They reported that frequency differences had the most marked impact on the relative ranking of individuals and were the main source of poor agreement between the two methods. They argued further that in the context of a FFQ, frequency may be more difficult to estimate than serving size, requiring complex mental calculations for which aids are generally not available. They propose cross-checking procedures such as asking respondents for global estimates of frequency for major good groups.

We have a greater understanding of respondent-related error terms and we continue to develop strategies to reduce the errors. We need more information about random errors in population subgroups and their impact on intended analyses. Larkin and her colleagues (Larkin et al., 1989) using the same data cited in the work of Flegal et al., (1988) compared nutrient intakes estimated from 16 food records and a FFQ and partitioned data by race, age, education and other variables including BMI. The smallest relative differences occurred for white men, the largest for black women, other variables including education and also BMI in the whites. Whether the differences are accreditable to under-reporting on the records or over-reporting on the FFQ needs further consideration.

Processing. The final and very brief comments are about data processing particularly coding. The brevity of the discussion does not reflect the importance of the issue. All of us have seen the literature documenting the potential coding-related error sources. One example is the work of the North East Regional group, directed by the University of Massachusetts investigators, who reviewed the coding decisions of 20 coders each given 30 records varying in quality from poor to excellent. Records in all categories presented problems to coders; coefficients of variation were small for some of the 30 records but considerable for others (Lacey et al., 1990). We have various opportunities for reducing these errors with standardized data collection procedures and consistent decision-making rules about data unavailable in data bases or unknown to respondents. Our own work in collaboration with the University of Minnesota's Nutrition Coordinating Center (Smiciklas-Wright et al., 1994) indicates that it is possible to achieve highly reliable interviewer/follow-up data management procedures.

Summary. This paper began with George Beaton's contention that dietary intake cannot be estimated without error and probably never will be (Beaton, 1994). He argued that improved estimation of error terms and appropriate analytical methods for coping with them will have more input on dietary assessment than will further improvements in dietary methods. I believe that we must continue to improve the methods as well as to develop appropriate statistical methods of coping with error terms. The challenge is not to be concerned with minutiae but to understand those errors which may contribute most, and for which groups of persons, to inaccurate dietary assessment.

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TABLE 1

Percentages of persons who correctly identified sameness and difference of amounts when presented with pairs of food items

Food	Standard Amount	Same Amount	← Different Amounts: Large Diff.-50%	Large Diff. +50%	Small Diff.-25%	Small Diff. +25% →
Corn	1/2 c.	96	99	95	98	68
Steak	4 oz.	84	100	42	83	59
Salad	1 c.	75	88	74	68	34
Cream Cheese	2 T	92	99	94	70	33

		No Intervention	Deeper Processing
Retrieval	Free Recall	Least Accurate	In between
	Recognition	In between	Most Accurate

Figure 1. Memory model and hpothesized results

From: Ervin, 1993

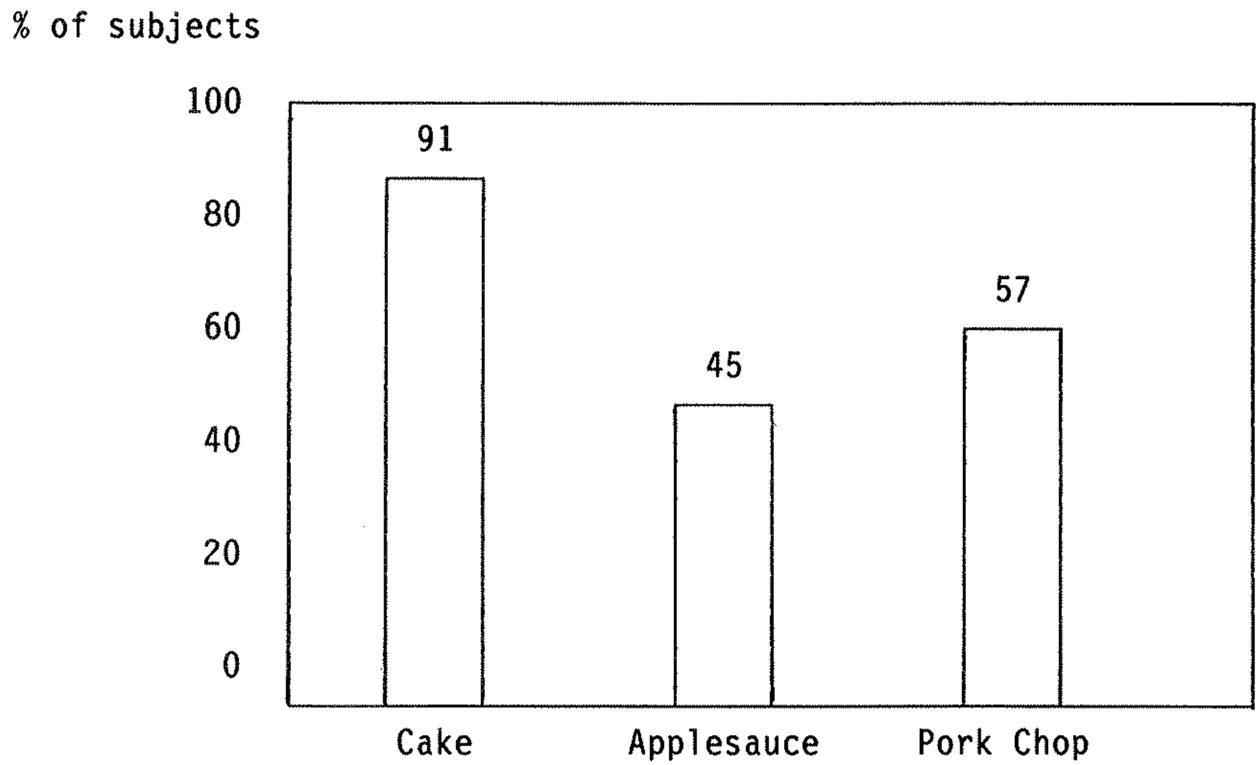

Figure 2. Recognition of serving size

From: Ervin, 1993

Adjusting for Intra-Individual Variability when Estimating Nutrient Intakes

Patricia Guenther, USDA-ARS-HNIS

This paper discusses a method of estimating the distribution of usual daily intakes for a dietary component, where "usual" is defined as "long-run average," which is effectively a year. Our approach is based on the assumption that an individual can more accurately recall and describe the types and amounts of foods eaten yesterday than the types and amounts of foods eaten over any longer period of time. We also assume that the nutrient data base used can also reflect the nutrient content of the foods eaten at that time reasonably well.

Dietary data contain both within- and between-person variation. When analyzing such data, nutritionists typically are interested only in the between-person variation. That is, they want to remove the within-person variation; or otherwise said, they are interested in the variation of "usual" intakes.

Nutritionists have sought to remove or minimize this within-person variation by lengthening the observation period from 1 day to as many as 365 days. The method we will discuss takes much of the burden of estimating usual intakes away from the subjects. They need only provide as little as 2 independent days of food intakes or 3 consecutive days of such information.

The Human Nutrition Information Service (HNIS) has been working cooperatively with statisticians at Iowa State University, who have developed what we call the ISU method for estimating usual intake distributions (Nusser et al. in press.) It is important to point out that the ISU method does not assume that the data under investigation are normally distributed or that they come from simple random samples. Neither assumption, although often made, is appropriate for most dietary intake data.

The ISU method assumes that a reported 1-day nutrient intake for an individual found in a food intake survey data set can be represented by the equation:

$$y_{its} = x_i + c_t + b_s + e_{it},$$

where y_{its} is the reported nutrient intake by individual i for date t, and s is the sequence number of the day for which the individual has provided intake information. The value we are interested in estimating is x_i, the usual intake of individual i. Also in the equation are c_t--the temporal effect on nutrient intake caused by the particular day of the week or season of the year--and b_s--the bias associated with intakes on a particular reporting day of the survey. The last term, e_{it}, is simply the difference between the reported intake, y_{its}, and the other three terms.

The ISU method assumes that the first day of reported nutrient intake values represent the truth. This means not only that the individual reports his or her food intakes correctly for that day, but also that the nutrient values assigned to those intakes represent the truth.

Whether or not there is bias on the first day of reported intake should not obscure one of the important attributes of the ISU method; namely, it removes the well-known biases of subsequent reporting days compared to the first. In addition to that, temporal effects, such as day-of-the-week and seasonal effects, are also easily removable from data sets in which such temporal factors are recorded.

Let us now explore the assumptions that individuals are correctly reporting their food intakes on the first day of the survey and that they are coded correctly and focus our attention on the quantity of a particular nutrient in 100 grams of a particular food eaten, which we will call the "nutrient density" of the food. The "within" variation we are looking at here is the within-food variation rather than the within-individual variation that the ISU method successfully deals with.

It is helpful to express the true nutrient density of a food eaten and then recorded in a survey data set as--

$$d_{it} = u + f_i + g_t + e_{it},$$

where d is the density; the subscript "it," again refers to individual i and survey data t; u is the true mean nutrient density of the food consumed by the population; f, is the potential variation across different individuals because they prefer and habitually consume different varieties or brands of the food, for example, because one uses mostly Heinz ketchup while another prefers Hunt's; and g_t reflects the potential variation of the nutrient density of the food over different seasons of the year. Finally, e_{it} is simply what remains after u, g_t, and f, are subtracted from d_{it}, the true nutrient density of the particular food eaten.

Ideally, if our goal is to estimate the distribution of usual nutrient intakes for a population correctly, we would like to remove the effects of season and purely random variation from our determination of the correct nutrient densities to use when translating reported food intakes into nutrient intakes. Unfortunately, this means that even if the nutrient data base we use gives us good estimates for u, the average nutrient density of a food consumed by the population, we will fail to incorporate the tendency for individual i to be different from his or her fellows, the f_i, in our equation. We recognize this problem, but we feel that the relative difference between, for example, the average vitamin A content in the brand of ketchup one person prefers to that another favors is very small compared to the relative differences in their total vitamin A intakes--small enough to be safely ignored. This leaves the question of estimating u, the average nutrient density of the food. USDA presently does this for the National Nutrient Data Bank (NNDB).

The great statistician George Box is credited with the saying "all models are wrong, but some models are useful." This should be the guiding principle in estimating the average nutrient content of foods in a data base. Estimating the average nutrient density of a food is, unfortunately, difficult and thankless work that will require the extensive use of models to be effective--models linking the foods analyzed to what is actually eaten and models reflecting the measurement errors inherent in lab work. The results may not be completely satisfying, but they will be generated using the best methods at our disposal.

We feel that error in the NNDB's model-based estimate for u, the average density of the nutrient content of food, is small compared to the variation in nutrient composition across foods of different types--small enough to be ignored in most cases. Nevertheless, USDA is engaged in strengthening the statistical underpinnings of the NNDB. It is investigating more sophisticated methods of combining data from various sources that will allow us to consider quality factors in the redesigned nutrient data bank. USDA will continue to consider what the appropriate mix of varieties and brand information should be.

Finally, we turn to the assumption that the nutrient values reported for the first survey day represent the truth. This means that the respondent actually reports correctly his or her food intakes on the first survey day and that we correctly translate these food intakes into nutrient intakes. USDA is working towards making this assumption more tenable. With researchers at the Census Bureau's Center for Survey Methods Research, it is investigating the cognitive aspects of the 24-hour dietary recall task. A multiple pass approach has been developed, which gives the respondents more time to think and focus on the recall task, and work is continuing to improve it. We believe that research aimed at reducing reporting error has the most to offer in terms of improving the quality of the estimates of usual nutrient intakes produced from dietary surveys.

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Perspectives on Data Quality - Panel Discussion

Lori Borrud, USDA-ARS-HNIS

I'm here representing the Nutrition Monitoring Division of USDA's Human Nutrition Information Service, now a part of the Agricultural Research Service, to present our perspectives on data quality.

The Nutrition Monitoring Division monitors the food intake of the general U.S. population and special high-risk subgroups by planning, conducting, and monitoring USDA's nationwide food surveys; compiles and maintains data on the composition of foods in order to identify the adequacy and quality of U.S. diets; and disseminates data and information through a variety of media. In each of these steps, we have implemented and maintained quality-control procedures to ensure the goal of releasing quality food and nutrient intake data to the public. We believe that data-quality efforts are continuous activities that must be integrated into all survey and post-survey data-processing operations. While these efforts encompass the use of food composition data, that is only one area of data quality we must address.

I would like to discuss our data quality perspectives in relationship to our Continuing Survey of Food Intakes by Individuals, or CSFII, and Diet and Health Knowledge Survey, or DHKS. USDA initiated the CSFII in 1985 to provide continuous dietary intake information on the U.S. population. The current, 1994-96, CSFII is the third in the series of individual intake surveys. The DHKS was initiated in 1989 as a telephone follow-up to the CSFII and is the first national survey designed so that data on individuals' attitudes and knowledge about nutrition can be linked with their food and nutrient intakes.

HNIS is conducting CSFII and DHKS 1994-96 as "What We Eat in America Survey." The survey contract was awarded in September 1992 to Westat, Inc. of Rockville, Maryland. Data collection for the "What We Eat in America" survey began in January of this year and will continue through 1996.

For CSFII and DHKS 1994-96 HNIS has implemented strong management and quality control procedures, both as part of the contract and in its in-house management of the surveys. A team of food survey specialists with experience in survey design, dietary methodology, food coding, data management, and statistics has been assigned specific responsibility for monitoring every task in the contract. The current CSFII and DHKS also include a number of survey design changes and improvements in survey monitoring and data management to speed the release of quality data.

Acceptable response rates are a first step in providing quality data to users. Procedures to achieve and maintain acceptable response rates have been established as part of the CSFII/DHKS 1994-96 contract. For example, the contract has requirements for specified response rates that must be met by the contractor.

In addition, a number of changes in the sampling and data collection methods have been made to reduce respondent burden, which in turn affects response rates.

To manage nationwide collection of data by close to 100 interviewers, the contractor uses an automated field management system that tracks the status of every questionnaire and the activity of every interviewer in the field. In addition, the system allows the supervisor to provide updated assignments and timely feedback to the interviewer.

The contract also specifies an automated forms tracking system to track the information collected in each interview from receipt of the data by the contractor to delivery of the processed data to HNIS. This tracking system is updated daily, allowing HNIS to track the status of any questionnaire. We believe these kinds of automated systems are needed to ensure that the response rates are being met, the sampling design is being followed, and the data are collected and processed according to the survey schedule.

For CSFII 1994-96, HNIS is using Survey Net, an automated food coding and nutrient analysis system designed specifically for use with the CSFII. We believe Survey Net will improve the efficiency of our technical support systems, leading to improved quality and timeliness of results. Survey Net was planned and developed jointly by HNIS and the University of Texas.

Survey Net was designed as a multilevel system for use by both the contractor and HNIS. Survey Net contains a number of user-friendly features that the contractor can use in coding food intake records received from the field. For example, the Survey Net RECIPE option allows the user to modify existing foods and recipes in the Survey Nutrient Data Base for foods reported in the survey. If modifications to the original foods are made, these can be saved to a recipe file. The on-line editing feature of the program permits the user to add, change, or delete foods. The system also contains built-in edit checks and quality control features such as weight or quantity extremes and range of response checks.

In addition, the coder is able to record unknowns. Or put another way, the coder is able to flag any foods or food quantities that cannot be coded for later attention at HNIS. This information is then transmitted electronically to HNIS on a weekly basis together with the coded food data from Survey Net.

On the HNIS level, Survey Net features allow us to monitor the data received from the contractor in a timely fashion, resolve unknowns, update data base files accordingly when new foods are reported, and approve recipe modifications. We can then send updated data base files electronically back to the contractor. In addition, Survey Net's built-in quality-control features provide a continuous review of recipes and food weights.

As part of our quality-control procedures, we have specified maximum error rates that the contractor must not exceed in coding the food intake data. In addition, all coders must pass certification based on test sets of intakes developed by HNIS before they are permitted to code.

In another change instituted for CSFII 1994-96, HNIS receives all survey data by weekly electronic transmissions from the contractor rather than through quarterly or yearly magnetic data tapes. Along with these weekly data transmissions, we receive reports of coding error rates, the status of interviews in the field and of data in-house at the contractor, and other information. All of this information enables us early on to identify and correct any problems in the field or during data processing and will permit the release of data more quickly than in previous surveys.

Data quality activities do not stop with the transmission of the food consumption data to HNIS. We have instituted an automated system to track survey data in-house, since we want to have a firm handle on how long each data processing step takes in order to identify in-house backlogs early. Once received at HNIS, all data are put through a rigorous automated in-house editing process and then review by the various specialists within the Division.

This comprehensive in-house review includes a review of the food intake data by our Survey Systems Team using Survey Net to ensure that recipe modifications were correctly made, codes and weights were correctly assigned, unknowns were resolved, and so on. Corrections are made and feedback is provided to the contractor weekly. Once the editing and review process is completed, the food consumption data are converted to nutrient quantities through the use of the analysis program contained in the Survey Net. Nutrient values per 100 grams of the foods for conversion of foods to nutrients are provided through the Survey Nutrient Data Base.

HNIS conducted a pilot study of all survey operations in the spring of 1993 and was pleased with the performance of Survey Net.

I would like to mention just some of our research activities that relate to data quality. HNIS has an on-going interagency agreement with the Center for Survey Methods Research, Bureau of the Census, to improve the reporting of foods through cognitive research. For example, CSMR recommended the use of a quick list and multiple passes through the day of intake. Intake questionnaires were subsequently revised based on this research.

An issue raised in recent years is the extent of underreporting that may exist in food consumption surveys. Mertz and colleagues have estimated that caloric intakes may be underreported by 18 percent based on their analysis of food records (Mertz et al. 1991). We recognize that underreporting may exist; however, at this time we do not know what foods are underreported or why underreporting occurs--whether it results from the data collection method, the method used for estimation of portion sizes, sociodemographic characteristics of the respondents, or some other reason. HNIS is addressing this issue through its collaborative work with the Center for Survey Methods Research and other planned research projects.

In an earlier paper, Patricia Guenther described our on-going collaborative work with Iowa State University to develop statistical methods that will use food intake data to estimate usual nutrient intake distributions. Iowa State University has now begun the much more difficult task of developing methods for estimating usual intakes of foods.

The Food Instruction Booklet, or FIB, which is used by the interviewers to probe for needed detail on the foods and amounts reported by respondents, has been revised for 1994-96. HNIS staff worked in-house and with our contractor to develop standardized probes written in the FIB to ensure that all interviewers collect the same level of detail in the same way for consistent coding of foods.

HNIS has worked to improve and strengthen every facet of the continuing survey in-house and contractually. But quality data also depend on the food composition data base used to convert reported foods and quantities into nutrients. Betty Perloff, in her paper, described the problems regarding food composition data in trying to compensate for limited resources. We must make sure that funding to implement the GAO recommendations will not draw funds away from needed research to support USDA's food consumption surveys.

For example, implementing GAO's recommendation to analyze each food at a cost of $2,000 per sample with six samples per food, or $12,000, is very much a budget issue. Over 1,000 new food codes were added to the Survey Nutrient Data Base during CSFII 1989-91 and we anticipate that as many or more will be added during 1994-96. Analytical costs for new food codes could be very high.

We all recognize that food composition data will continue to improve over time. More data continually become available, better analytic methods are developed, and so on. When many current analytic methods need improvement, questions may arise such as why scarce resources should be spent at this time to increase sample sizes. An option may be to explore innovative ways to make the best use of available data. As one means of doing this, HNIS is developing the Survey Nutrient Data Base for Trend Analysis.

The trends data base will allow previous intakes to be adjusted to account for known improvements in food composition data and will also allow measure of changes in nutrient intake levels resulting from various types of real changes in foods. This data base should be available in about a year.

I would like to briefly mention the issue of brand names. We believe that this issue requires careful consideration before we move ahead quickly to add brand-specific nutrient data to the data base. For example, how often are respondents able to provide accurate brand name information for food items? When is brand name information needed and for what purpose? Do we know which brand name food items may be similar, if not identical, in nutrient content? The addition of brand name information to the nutrient data base will require considerable effort and expense. Are we sure that the addition of this information will result in improved food composition data or, more precisely, in improved estimates of intakes?

To close, I want to reemphasize that while HNIS is actively addressing GAO's concerns, decisions to implement GAO's recommendations will have budget implications, since other program needs must also be met. However, HNIS believes that moving ahead with programs such as the nutrient data base for trends analysis will improve the use of current data for research purposes. Our pursuit of sophisticated statistical methods for combining data from different sources in order to consider quality factors in the redesigned nutrient data bank may be the direction we have to take, not only statistically, but in consideration of the budget constraints we must live with.

HNIS believes that quality nutrient intake data depend not only on a quality food composition data base but also on a quality survey as well. We are moving ahead, taking into consideration the total picture.

Reference

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Perspectives on Data Quality -- an NCHS Perspective

Margaret McDowell, Centers for Disease Control and Prevention

NCHS has used the USDA Survey Nutrient Data Base (SNDB) to code and report Health and Nutrition Examination Survey (HANES) dietary intake data since 1982--beginning with Hispanic HANES, 1982-84. NCHS recently reported mean total fat and saturated fat intakes based upon NHANES III-Phase 1 24-hr dietary recall data which were collected between 1988 and 1991. NCHS plans to release data tapes and reports on total nutrient intakes estimates later this year. The Phase 1 estimates were computed using the USDA Survey Nutrient Database food composition data.

The survey databases which are used to code, quantify, and compute dietary intake estimates are an important source of documentation for HANES data users. HANES dietary data have been used to estimate total nutrient intakes, to examine changes in nutrient intake over time, to explore diet-health relationships, and to examine food sources of nutrients and other food components. Research applications such as these require well-documented food composition databases whose data can be traced to reliable and accurate data sources.

NCHS references or releases the food composition database used for each HANES. As the demand for information about new food components increases, so will the need for a flexible survey database system which is capable of providing rapid turnaround on emerging health and safety concerns involving the U.S. food supply.

NCHS supports efforts to improve the quality and specificity of the USDA food composition database. NCHS staff participate in several National Nutrition Monitoring and Related Research Program (NNMRRP) activities including the Interagency Working Group on Food Composition Data and the National Nutrient Data Bank Users Group. Resources and support from data users are needed to achieve the long-term goal of a comprehensive U.S. food composition database system.

Perspectives on Data Quality - Panel Discussion
"Observations from a Clinical Research Center"

Phyllis Stumbo, University of Iowa, Iowa City, IA

As a nutritionist in a small research unit (1) I find that food composition data is not well understood by investigators in other fields. I think we, as nutritionists and dietitians, are responsible for this situation because we often quote nutrient data in absolute terms. In our zeal to make nutrition understandable we sometimes over-simplify food composition. Our clients may not understand that when we say bread has 70 Calories per slice, an apple has 80 Calories, or a Cookie 120 Calories that we are talking about averages. They usually have no concept of how much variability may occur in food composition data.

My investigators understand the composition of other biological compounds. They know that the normal value for hemoglobin is 14 mg% with a range of 12 to 16 and that men generally have higher values than women. No one expects hemoglobin to be exactly 14 mg%. It is routinely measured because it can vary from 6 to 26 mg%. But our food tables and simplified educational messages have led our audiences to expect simple answers. As a result, most investigators would not expect an apple to vary from 50 to 100 Calories. Most people have never seen a range of normal values for nutrient composition data, rather they expect a food table to resemble the absoluteness of Boyle's gas laws.

So how does this affect my work? I operate the nutrition service in a small NIH research center in Iowa. In my unit we devise diets with known composition for a variety of studies. We do this by designing diets using food composition data primarily from USDA Handbook 8, Composition of Food, Raw, Processed, Prepared (2). Our studies always control for carbohydrate, protein, fat, and the major fatty acid classes; usually they are controlled for sodium, potassium, calcium, and phosphorus content, and sometimes for nutrients as diverse as biotin or carnitine. Diets are planned by calculating the nutrient composition of menus. The decision to analyze diets to verify calculations is made individually for each study and generally food analyses are conducted sparingly. Murphy, Watt, and Rizek warned researchers of the limitations of food tables for metabolic research in 1973 when they wrote:

"... a potential and serious misuse of the tables deserves some comment. In a few instances, inquiries from researchers have indicated that they would like to calculate nutrients in diets used in metabolic studies. The temptation to cut costs and save time by taking this kind of shortcut is enormous. However, in metabolic research where great precision is required, only analysis of an aliquot of the particular foodstuffs being consumed will have sufficient accuracy for balancing intake of nutrient against utilization by an individual at a specific time." (3)

Inspite of the known variability in food composition and warnings from developers of the data, we in the field find using USDA food composition data to calculate research diets to be effective and efficient. Deciding when calculations will suffice and when analysis is required involves a cost/benefit analysis. Some studies do not require the accuracy of analysis. Analysis of multiple nutrients is expensive. We are fortunate at Iowa to have a nutrition laboratory set up to conduct assays on food for a variety of nutrients. They are not set up at our convenience, rather our samples are analyzed at their convenience -- a relationship I nurture, because without their service we could conduct fewer analyses and the cost would be higher.

An obvious question when determining cost vs. benefit of diet analyses is "How well do calculations of diets reflect actual analyses?" To answer this question I reviewed results of analyses of diets we have prepared over the last ten years. Sometimes analyses closely agree with calculations and sometimes they do not. Below are examples that illustrate our experience with diet calculations and subsequent food analyses.

Figure 1 shows a series of nitrogen analyses from 12 different menus for 12 subjects who consumed their same daily menu for 10 days. Each circle represents the 11th diet which was prepared along with the previous 10 and reserved for analysis. This additional diet is sometimes referred to as a "second" tray since it duplicates the "first" tray which is consumed. The solid line on the graph represents our calculated value and the dotted lines are + 10%. In these studies the results of the analyses are not known until several days or weeks after the study is completed. You might contrast the variability we experience in our data to the variability allowed in a current multicentered study who require the 95% confidence interval to be + 1.5% as opposed to our variability which might exceed 10%. If we set the confidence interval this tight we would lose over half of our diets which was exactly the experience of the Delta study (4). As they prepared their meals; at least half of the menus they developed had to be reformulated to meet the tight criteria (5).

In a second study, potassium control was needed so on two occasions we prepared a second tray for analyses for each of 11 subjects. We used one basic menu with food amounts increased or decreased to hold potassium content constant while adjusting Calories to meet the subject's requirement. Figure 2 shows the duplicate analyses ordered from left to right to show decreasing agreement between analyses of the duplicate trays. A few diets analyzed exactly like their matching tray, but some varied as much as 10% from their corresponding diet which may reflect a combination of preparation and analytical variation. However, most of the diets provided less than the calculated amount, with the mean value for the first diet analysis being 94% and the second diet 95% of the calculated amount.

Sometimes we encounter diets difficult to achieve with food. Our diets that provided 10 and 400 mEq sodium are an example of this problem. We rarely analyze individual foods, but when we found that one of our two high sodium menus provided 40 mEq less sodium than the other we analyzed some of our high sodium products. In doing so we discovered that the two broth products we used had different sodium contents (Figure 3). Diets which included beef broth had vastly different sodium values than similar diets which included chicken broth, reflecting differences in the two broths. Here we might ask, is the food table "wrong" because it does not show the same sodium content as the broth, or is the broth "wrong" because it does not provide the same amount of sodium as the table?

In general, analyses we have conducted over the past 10 years have shown that calculations effectively predict the composition of mixed diets, but they do not fully explain the variability we sometimes observe. As we have tried to reconcile differences between calculations and analyses, the most obvious sources of variation are variability in the preparation of the diet or analytical variability in the laboratory. We must continually monitor our preparation methods to eliminate variability in the kitchen. But I need more experience in monitoring analyses conducted outside our kitchen.

One valuable outcome of the National Nutrient Databank for me is learning how to evaluate analytical data. I would like to see more guidance on how to monitor my own analytical data. What questions should I ask the laboratory about their quality control? What should I ask the laboratory about their methodology? What I really want from the USDA is a "cook book" of analytical procedures for the foods laboratory. Dietitians and nutritionists have many opportunities to be familiar with variation in food quality and preparation methods, but relatively little opportunity to understand variation in analytical methodology. A manual providing guidance to the practitioner who must contract for food analyses would enable researchers to use food tables more effectively.

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5. Personal Communication, Kent Stewart, PhD, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, May, 1994.

Figure 1. Calculated versus analyzed protein content of different low protein diets (1991-1993)

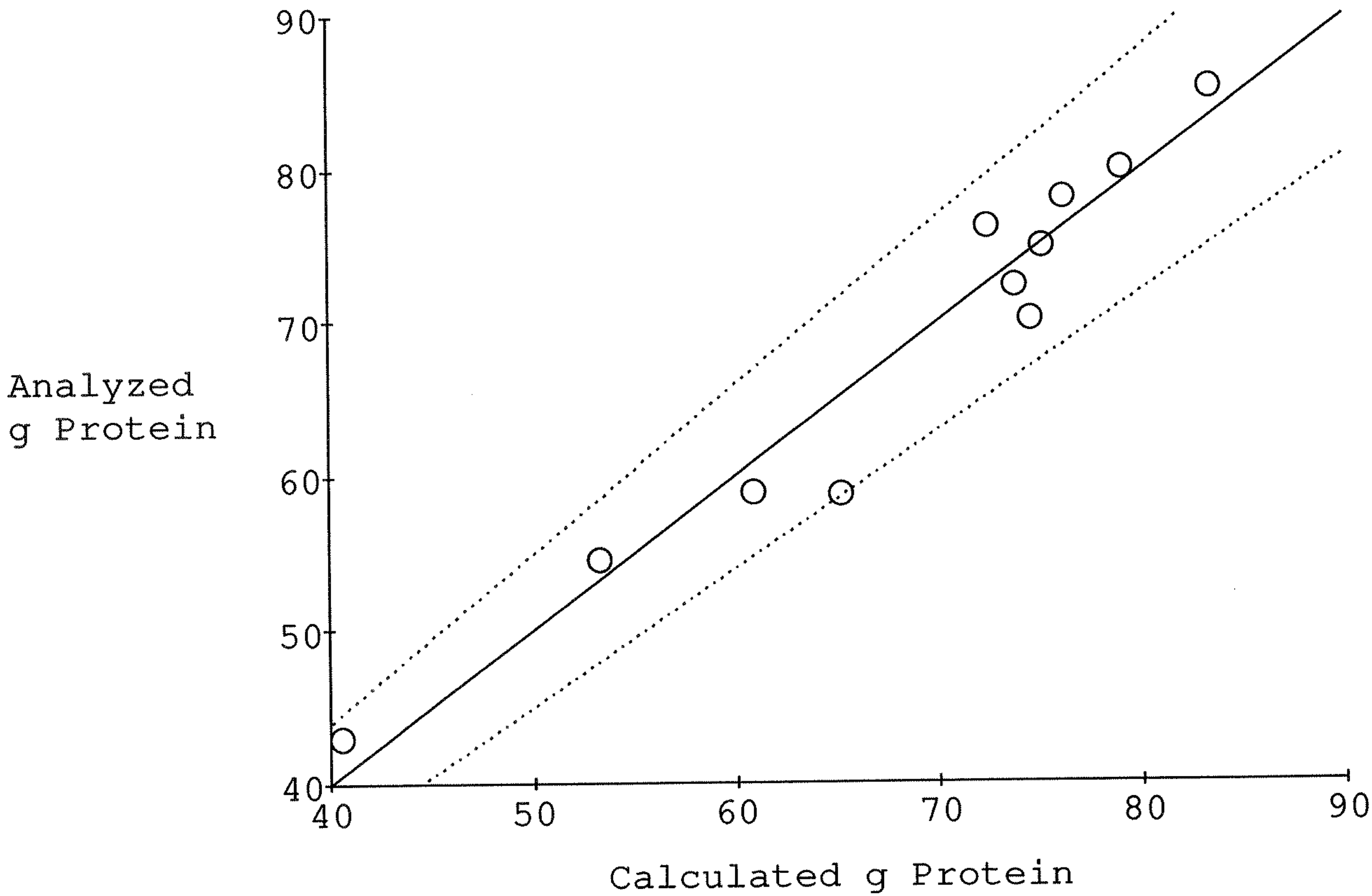


Figure 2. Percent differences between potassium analyses of duplicate 102 mEq potassium diets (1989)

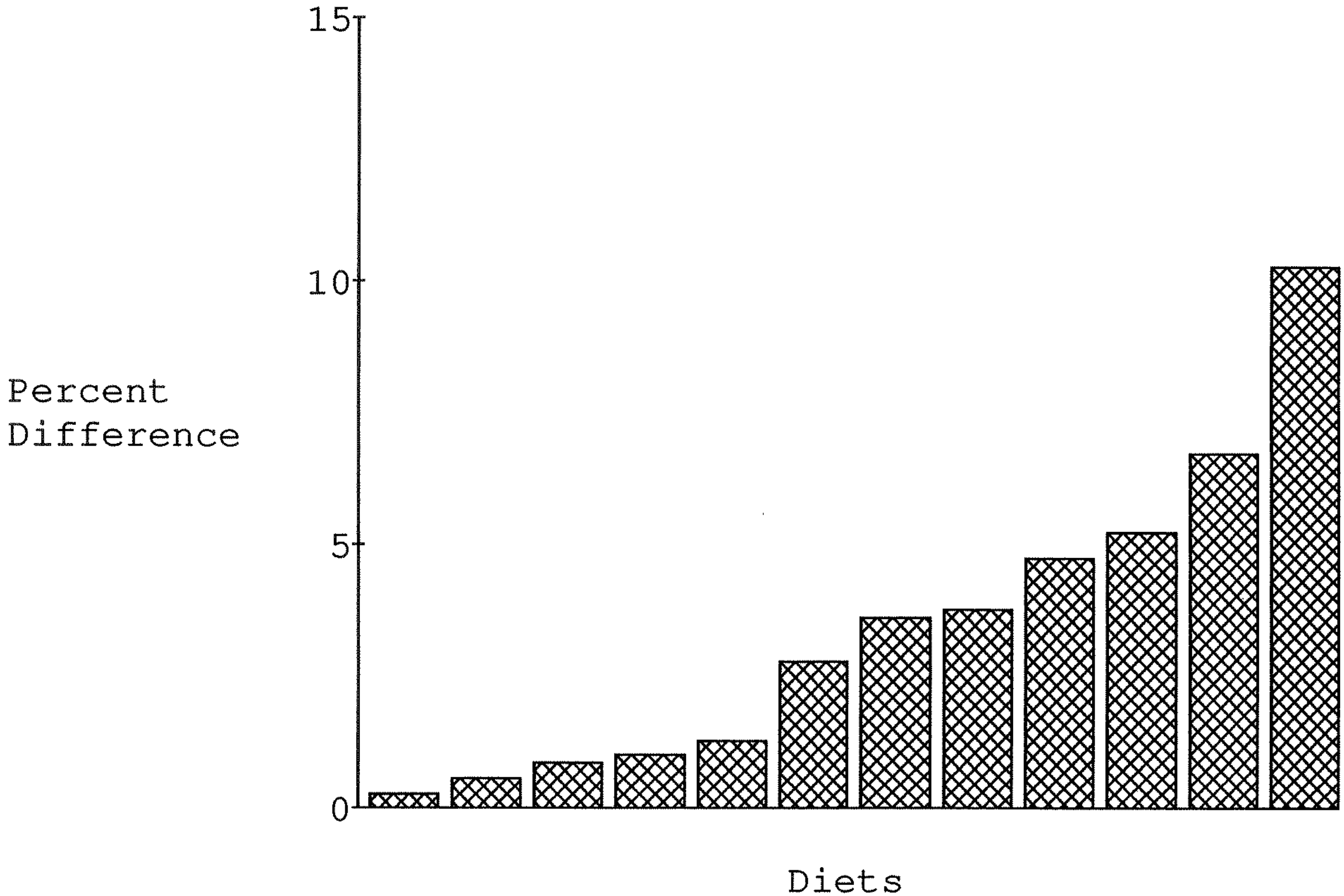
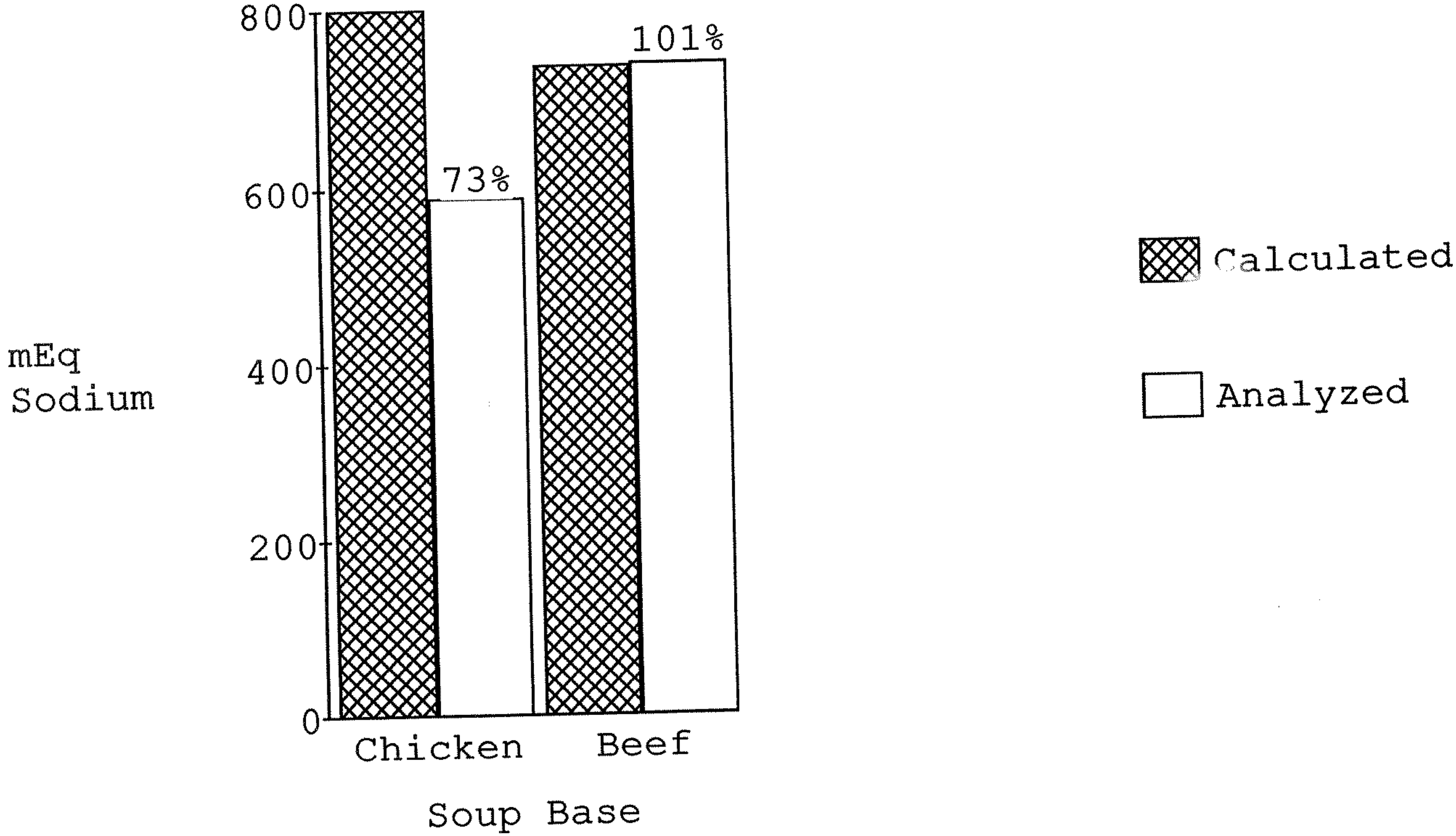


Figure 3. Calculated and analyzed sodium content of 100 grams soup base (U of Iowa, 1986)



Perspective of Data Quality - Panel Discussion

Sue McPherson, University of Texas

Accurate and reliable nutrient information are needed for the public, for researchers, for industry, and for government and policy making agencies. It is also critical that these nutrient data be clearly documented and be distributed in a timely manner. Because the USDA HNIS is the principal source of these nutrient data, the burden of responsibility for establishing the criteria to provide the accurate and reliable data has become their charge. History has shown that the appropriate level of funding which could support this difficult charge has not been available.

Handbook 8 is the best resource of nutrient data available to the public. The data in Handbook 8 are the most comprehensive compilation of nutrient data available for public, research and government uses. The comments of the GAO report were not "news" - they were a statement of the problems and difficulties involved in the compilation of a nutrient data base. The GAO report states, "it is critical that Handbook 8 be as accurate as possible". USDA HNIS has been charged with this task, yet underfunded to implement the process.

USDA HNIS is faced with many difficulties in its efforts to create Handbook 8. First, the major source of nutrient data is the food industry and compliance is voluntary. When data from industry are made available they seldom contain adequate documentation. Yet the public demands nutrient data as soon as possible, thus often industry data are used, until more reliable are available. Second the selection of foods for contracted laboratory analyses must be prioritized due to the high costs, thus only a few foods can be done each year. Thus, if USDA did not utilize industry data, some foods available in the market place might not show up in the nutrient data base for years. A third difficulty lies in the area of standardization of the review criteria used by the nutrient data staff. Over the years there has not been adequate resources to provide the coordinated approach to the review of the entire Handbook, rather it has been done in segments with specialists in each area working independently.

As the discussion today has indicated USDA HNIS can not accomplish all of the GAO requirements with the current budget. Thus, as users and consumers of this necessary nutrient information, we need to help formulate alternative approaches to the creation of more accurate and reliable nutrient information through alternative mechanisms in support of the USDA/HNIS goal to facilitate the successful completion of this charge. Specifically, if USDA/HNIS were to be the manager, repository and distributor of the nutrient data, perhaps an assortment of other support mechanisms could be developed to insure that the data provided to USDA/HNIS were accurate and reliable. Perhaps if there were legal requirements for the development of the labeling information which would require standardization of the development of analytic values for foods which would be required to be submitted to USDA/HNIS. Thus, the quality of this outside information could be better defined than is the current practice. An advisory group could work as an additional quality control device to review the nutrient data to develop quality control codes which could identify the level of quality of each piece of information. Because this is an evolving process, there would always be some nutrient information that was very detailed from analytic values and other data from manufactures which was very poorly documented. However, the consumer of this nutrient information could tell from these codes the level of quality of the information. The timeliness of the distribution of the data is a high priority and can not be hampered by the quality control process. The responsibility for the quality of the nutrient data should not be shouldered by just one agency, it should be shared, if we are to succeed.

NUTRITION MONITORING UPDATES

Nutrient Composition Laboratory
Gary Beecher, *U.S. Department of Agriculture,*
Agricultural Research Service

USDA Nutrient Databank
David Haytowitz, *U.S. Department of Agriculture,*
Agricultural Research Service-Human Nutrition Information Service

Food and Drug Administration
Jean Pennington, *U.S. Food and Drug Administration*

The Dietary and Nutritional Status of Americans: What the Nutrition Monitoring Program Shows
Debra Reed, *U.S. Department of Agriculture,*
Agricultural Research Service

NHANES
Margaret McDowell, *Centers for Disease Control and Prevention,*
National Center for Health Statistics

CFSII/DHKS
Lori Borrud, *U.S. Department of Agriculture,*
Agricultural Research Service-Human Nutrition Information Service

International Nutrient Database Activities
Joanne Holden, *U.S. Department of Agriculture,*
Agricultural Research Service

Nutrient Composition Laboratory

Gary Beecher, USDA-ARS

As part of the recent reorganization of the Beltsville Human Nutrition Research Center (BHNRC), the Food Composition Laboratory acquired its new name. In addition, other laboratories of BHNRC were reorganized, renamed and the direction of research aligned with current diet-health relationships (See Table 1).

Recently, part of the former Human Nutrition Information Service was integrated into BHNRC. These activities include the National Food Consumption Survey, the National Nutrient Data Bank and associated activities. Details of the organization are presented in Table 1.

The research activities of the Food Composition Laboratory (FCL) are an integral part of the National Nutrition Monitoring and Related Research program of the federal government. The ongoing research by scientists at FCL is outlined in Table 2. All research efforts at FCL are focused on the development of new food composition data as well as the improvement of existing data. Specifically, food analysis and the development of analytical methods and instrumentation are oriented toward those nutrients and food components associated with the reduced risk of diet-related diseases. Efforts in the improvement of data quality emphasize three areas of research, data evaluation, food sampling and reference materials (Table 2).

Research in several areas will be reactivated or started in the near future (Table 3). Again, each of the nutrients or food components identified with these research thrusts are associated with diet-related disorders or diseases. Research on these food components will be conducted collaboratively with scientists at the University of Minnesota, National Center for Health Statistics and Iowa State University. All research that has the potential to impact on the activities of the Nutrient Data Laboratory (USDA Handbook No. 8 and Nutrient Data Bank) is conducted collaboratively with scientists and staff of that group.

The Food Composition Laboratory has been well represented by its scientists and staff at national and international meetings, symposia and workshops. A list of scientific publications for Calendar Year 1993 is attached. Copies of each publication are available upon request.

Table 1.
Organization of Beltsville Human Nutrition Research Center
Center Director - Dr. Joseph Spence

Diet and Human Performance Laboratory

Research Leader - Dr. Joseph Judd
Define healthy diets through studies with human subjects.

Metabolism and Nutrient Interactions Laboratory

Research Leader - Dr. Judy Hallfrisch
Ascertain metabolism of specific and combinations of nutrients and food components.

Nutrient Requirements and Functions Laboratory

Research Leader - Dr. Orville Levander
Define dietary requirements for individual nutrients and food components.

Food Composition Laboratory

Research Leader - Dr. Gary R. Beecher
Develop new and improved analytical techniques and other systems for the improvement of food composition data.

Nutrient Data Laboratory

Acting Research Leader - Dr. Wayne Wolf
Collate, tabulate and disseminate data on the composition of foods.

Survey Systems and Food Consumption Laboratory

Acting Research Leader - Ms. Alanna Moshfegh
Conduct national food consumption surveys and disseminate information relative to the intake of foods, nutrients and other food components by the U.S. population

Table 2. Current Research Activities at the Food Composition Laboratory

Measurement Systems Development (Includes extraction/digestion, sample cleanup, separation/quantification).

- Cholesterol
- Dietary fiber
- Fatty acids
- Flavonoids
- Minerals
- Tocopherols and tocotrienols
- Vitamin C

Instrumentation Development

Minerals - Simultaneous multi-element; organic/non-organic speciation

Improvement of Data Quality

Data evaluation - Development of systems for the critical evaluation of the quality of analytical data

Food sampling - Development of demographic and statistical based schemes

Reference materials - Research on organic nutrient stability

Food Analysis

Carotenoids in tomato products

Table 3.
New Research Areas at the Food Composition Laboratory

Carotenoids	Develop analytical methods for moderate and high fat foods Update database
Folate	Develop extraction and analytical methods
Isoflavonoids	Measure levels in soya-foods and other legume foods Develop database

FOOD COMPOSITION LABORATORY
PUBLICATIONS
January 1, 1993 - December 31, 1993

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USDA Nutrient Databank

David Haytowitz, USDA-ARS-HNIS

Introduction

There is an ancient curse which states "May you live in interesting times." The past year, with all the changes it has brought, has certainly been interesting. With change comes opportunities. Once a separate agency within the USDA, the Human Nutrition Information Service (HNIS) is now part of the Agricultural Research Service (ARS). We have worked extensively with our colleagues in ARS in the past and look forward to working even more closely with them in the future.

In addition to being moved in the departmental organization chart, we are also physically moving. Our new offices will be in Riverdale, which is a couple of miles from our current location. By next year we will know our new address and phone numbers. In the meantime we will keep you informed by posting messages on the Internet and other bulletin boards.

Last October, the General Accounting Office's (GAO) report entitled "Better Guidance Needed to Improve Reliability of USDA's Food Composition Data" was released. In another paper in these proceedings, Betty Perloff describes GAO's recommendations and the steps we are taking to implement them.

This paper covers some of the activities of the Nutrient Data Research Branch, which is responsible for compiling representative food composition values. These values are made available to researchers around the world both in printed form as Agriculture Handbook No. 8 (AH-8) and its machine-readable form, the USDA Nutrient Data Base for Standard Reference. The data are also used in specialized data sets for the food surveys conducted by USDA, the NHANES survey conducted by the DHHS, and the National Nutrient Data Base for Child Nutrition Programs.

Bulletin Board

The Nutrient Data Bank Bulletin Board, which has been operating since 1990, continues to serve as a method of data dissemination and announcements about HNIS publications and the Nutrient Data Bank Conference. It is accessible by individuals and institutions and enables them to transfer nutrient data directly to their own computers. This information is updated and revised monthly.

The board operates 24 hours a day, 7 days a week, and averages over 350 callers per month from nearly every state in this country and some foreign countries including Australia, Japan, and others. In addition to the files described below in greater detail, some of the other files currently on the Bulletin Board include data from Home and Garden Bulletin No. 72, "Nutritive Value of Foods, Home Economics Research Report No. 48, "Sugar Content of Selected Foods", and the Provisional Tables on Selenium and Vitamin D. There are also data sets containing bibliographic and other information of interest to nutrient data users prepared by the Food and Nutrition Information Center at the National Agricultural Library. The telephone number for the Bulletin Board is 301-436-5078.

Internet

In cooperation with the University of Maryland, the data and information on the bulletin board are also available over the Internet. To get to our data type:

telnet info.umd.edu

at your system prompt and select the following items from the menu:

Educational Resources
Government
United States
Executive
Nutrient Data

Some of you may have encountered some problems finding our data recently. This happened when the University of Maryland reorganized their directories. The new location of our data in the directory structure, which is only slightly different from before is listed above. If, in the future, you have problems finding our data, send me a message on the Internet at:

info-12@info.umd.edu

Progress

Release 10

Release 10 of the USDA Nutrient Data Base for Standard Reference was released in July 1993 and made available at NTIS, on the Nutrient Data Bank Bulletin Board, and on the Internet. This release added new data from AH-8 sections on Baked Products (AH-8-18), Snacks and Sweets (AH-8-19); Fresh Pork, and the 1990 and 1991 supplements. In addition, reflecting improvements in the availability of data, crude fiber data was dropped and replaced with data on total dietary fiber (TDF). While TDF data was available for only about 3000 items, this information will be updated and expanded in future releases.

AH-8 Supplements

HNIS continued updating "Composition of Foods...Raw, Processed, Prepared," Agriculture Handbook No. 8 (AH-8) by issuing last year the fourth in a series of supplements to the handbook. These supplements give us an opportunity to add new data which have resulted from contracts and data collected from other sources as well as updating items previously published in the 21 sections of AH-8. This last supplement contains new or revised data for 59 food items in 11 sections of AH-8. These data will be incorporated into the next release of the USDA Nutrient Data Base for Standard Reference. For those users who wish to access the data now, it is available on the Bulletin Board. The 1993 supplement is in preparation and will contain data on cooked beef and lamb cuts trimmed to 1/8" external fat. Planning for the 1994 supplement has begun. It will include data on processed eggs and data on other foods from current contracts.

New Beef and Lamb Data

In February 1994, data on 56 cooked beef and 14 cooked lamb cuts trimmed to 1/8" external fat was made available on the electronic bulletin board. These data on a 100 gram basis only were released electronically so they could be used for nutrition labeling. Based on market studies the Food Safety and Inspection Service (FSIS) of the USDA is requiring that the cooked edible portion consisting of lean and fatty tissue of meat cuts trimmed to 1/8" fat be used for nutritional labelling. However, AH-8 contained meat data on 1/4" and/or 0" trim. Therefore a team of cooperators was organized by HNIS and the National Live Stock and Meat Board to produce nutrient values for 1/8" trim external fat for beef and lamb cuts. The cooperators were HNIS staff, meat scientists from Texas A&M University, a statistician from the University of Maryland, and representatives from the National Live Stock and Meat Board and FSIS.

Based on fat trim data collected from a market basket study, regression equations were developed for raw meat cuts which predicted the amount of fatty tissue lost due to trimming from 1/4" trim external fat to 1/8" fat. The nutrient composition of 1/8" trim raw meat cuts were then calculated from those equations, and cooked composition data were developed from the raw data. The meat industry will use these data to implement its point-of-purchase nutrition labeling program "Nutri-Facts™," as required by the USDA.

Survey Nutrient Data Base

The USDA Nutrient Data Bases for Individual Food Intake Surveys used in the 1989, 1990, and 1991 Continuing Survey of Food Intakes by Individuals were also released. These data bases were also used for analysis of NHANES 3, phase 1, data. The Primary Nutrient Data Set (PDS), the Nutrient Retention Factors, and the Recipe File, which contain data used to create each version of the survey nutrient data base were released at the same time. Beginning with the next release (CSFII 1994) the formats for the data base will change. Lois Steinfeldt discusses the new formats and some helpful information on using them elsewhere in these proceedings.

National Nutrient Data Base for Child Nutrition Programs (NNDCNP), Release 1

A new activity which we have undertaken in cooperation with the Food and Nutrition Service is development of the National Nutrient Data Base for Child Nutrition Programs. It will be used in a demonstration project of Nutrient Standard Menu Planning (NSMP) starting in the 1994-95 school year. The NSMP will require that school meals meet the goal for selected nutrients of 1/3 of the RDA for lunch or 1/4 of the RDA for breakfast as well as not more than 30% of total calories from fat. In the NSMP demonstration project, participating schools will analyze the nutritional composition of breakfast and lunch menus utilizing a software package which incorporates the NNDCNP. Software packages are being prepared by a variety of vendors. The NNDCNP was described in greater detail at a workshop held for potential vendors and others during last year's conference in Baton Rouge.

The data base will contain data on 15 nutrients from the Standard Reference data set as well as brand name data submitted by food processors. To facilitate the submission of processed food data, an electronic form was developed which has been sent to several hundred food processors. This form enables the food processor to enter the data on a diskette and submit it to HNIS for inclusion in the data base. For companies supplying large amounts of data, information is available on how they can export the data from their own data bases and send it to us in ASCII format. Along with the nutrient data, companies are also required to submit information on the quality control procedures used to insure the accuracy of the data. Once the data are submitted we will check it for completeness and accuracy. These data will become available in subsequent releases of the data base.

Release 1 of the NNDCNP data files was made available on the Bulletin Board earlier this year. Accompanying the files was a document describing file formats.

Vitamin K

A revised Provisional Table on the Vitamin K Content of Selected Foods was also released, and copies are available from our office. The revised table contains vitamin K values for 194 food items analyzed by HPLC. These values replace and add to those published in 1990. Values analyzed by bioassay in the 1990 table have been dropped. A corresponding data set is also available on the Bulletin Board.

Contracts

We have a couple of important contracts under way. One is analysis of the proximate, mineral, and vitamin content of selected ethnic foods such as Puerto Rican cheeses, several peppers, rice paper, and taro stems. A companion contract covers fatty acids and sterols for the same foods. We have received data from the first year of these contracts and work is well under way on the second year. Depending on the availability of funding, we may have a third year and will be able to analyze additional foods. These data are very helpful in assessing the diets of survey respondents for CSFII and NHANES from various special population groups. The data will be released as part of the survey nutrient data sets and in future releases of the Standard Reference Data Base.

Another contract, which will be completed shortly, covers dietary fiber and individual sugars for 85 high-consumption foods. Total dietary fiber will be determined by summing the values for soluble and insoluble fiber. Sugars being analyzed individually by HPLC include glucose, fructose, sucrose, maltose, and lactose. The fiber data will be used to update the primary data set and the Standard Reference Data Base. The sugar data will be available in publications and on the Bulletin Board.

Plans

Nutrient Data Bank System Redesign

Another major activity is the redesign of the Nutrient Data Bank System. Since we started using the current system in 1985, many technological advances have occurred and we have undertaken additional activities which cannot be adequately supported by the current system. This redesign will give us a new state-of-the-art system utilizing a relational database management approach, enabling us to more efficiently meet our current data processing needs and providing the flexibility to add new functions when required.

Dr. Loretta Hoover spent 6 months with us last year reviewing the current system, suggesting areas for improvement, and working with staff to develop design objectives for the new system. A users' group comprising other nutrient data users in the Federal Government was also formed last year, and has met twice. During one of its meetings Dr. Hoover presented some of the results of her work with us.

A number of teams were formed to work with Dr. Hoover on a variety of subjects relating to the NDBS redesign. After discussing a wide range of issues relating to these subjects, a number of working papers were developed in the following areas: analytical methods, calorie factors, commercial products (food labels) support file, data screening and quality evaluation, data derivation codes, fatty acids and lipid factors, formulations, identification numbers and data fields, nitrogen-to-protein conversion factors and protein quality, data integrity equations, and retention factor files. In addition recommendations for statistical requirements for the new system were provided by the National Agricultural Statistics Service. Meetings were also held to discuss quality issues. These working papers and recommendations will guide us in the redesign of the system.

As part of her assignment Dr. Hoover looked at how other countries were using computer-based systems for managing their food composition tables. During her investigations she discovered EuroNIMS, a data management system for food composition data developed for six European countries. Dr. Thierry Arnouts from Belgium was invited to present the EuroNIMS system to the NDRB staff. During his visit discussions were held to determine how this system could meet USDA and user needs. Hardware and software to support the EuroNIMS system has been ordered. This will enable us to conduct "hands on" testing, as well as determining if EuroNIMS will meet our needs. During the testing phase we will also identify where enhancements may be needed to meet the requirements identified in the working papers described earlier. Adoption of the EuroNIMS software will result in considerable cost savings, not to mention savings in the time needed to design, write, test, debug, and install a new system. It will also facilitate the exchange of data with other countries using the system.

We also visited FDA for a demonstration of the Langual coding system, the International Interface Standard for Food Databases, and software being developed under contract for FDA by TAS, Inc. Data fields in the Food Labeling and Packaging Survey (FLAPS) conducted by FDA were also compared with the Commercial Products Support File which we will incorporate into the revised system.

This system redesign will enhance NDRB's continuing efforts in the development of representative food composition values for users within the Government and outside. The redesign will also take advantage of improvements in computer hardware and software technology.

Release 11

Release 11 of the USDA Nutrient Data Base for Standard Reference is planned for release in late 1994. It will include data from the 1992 and 1993 Handbook No. 8 Supplements. Data on the vitamin E content of foods, derived from various forms of the vitamin, will also be included and reported as milligrams alpha-tocopherol equivalents.

Format

As well as adding new data, we will adopt a new format for the Standard Reference data set. The new format will allow easier importing into a variety of applications such as data base management systems, spreadsheets, statistics programs, and others. This new format will be very similar to those presented last year in Baton Rouge for the Survey Nutrient Data Sets and the Nutrient Data Base for Child Nutrition Programs. However, there will be additional fields in order to present some information unique to the Standard Reference Data Base. These include a new field for source information which is now contained in the standard error field. In the new format, the standard error field will only contain the standard error. A new field will be added designating the food group. In the future, this format will allow us to provide more detailed information requested by our users. Initially, some of these fields may be blank or contain default values, but as this improved data base matures, more information will become available.

This new format will also include more complete food descriptions. This will eliminate the need for abbreviations in the long names. The short names will also have fewer, easier to understand abbreviations. There will be the capability for additional household descriptions and weights. Initially, there may only be the existing two household measures, but more will be added in subsequent releases. Plans are underway to add another file which would include the text of footnotes which appear on many of the printed pages of Agriculture Handbook No. 8. Much of these data were previously unavailable to users of the machine-readable data sets. Once the format is finalized, we will provide documentation along with a sample data set on the bulletin board.

Interim Releases

In order to disseminate data to you and our other users in a more timely manner, we will begin issuing interim releases to the standard reference data base. This will enable us to make minor updates and corrections without waiting for one of the supplements or a major release. The exact timing of the interim releases will depend on the amount of data available and staff resources. The interim releases will be numbered 11.1, 11.2, and so forth. The interim releases will only be available on the bulletin board and Internet. With each interim release, we will provide the complete standard reference data set with the updates and additions incorporated. A second data set will contain only those foods items which changed with the interim release. Only major releases (11.0, 12.0, ...), occurring approximately once a year and coinciding with the publication of a supplement, will be sent to the National Technical Information Service (NTIS) for sale. Once a major release is made available, the previous interim releases will be removed.

Computer Programs

A new in-house program has been written to improve the ability of our staff to query the USDA Nutrient Data Base for Standard Reference, and we are looking for a few beta testers to help us evaluate the program. Queries can be made by food description or by NDB Number. The queries can be limited to specific nutrients or food groups. Output from the queries can be displayed on the screen or saved in a file. This file can then be printed or imported into another application. If you are interested in becoming a beta tester for this program, let me know and we will send you a copy. This program uses the current format of Standard Reference.

As always, we welcome your suggestions as to how we can improve any of the products and areas I have discussed and look forward to your input.

Update of FDA Activities Related to Databases

Jean Pennington, FDA

Total Diet Studies

Five reports were completed for the data from the Total Diet Studies from 1982 to 1991. Three of these reports concern the levels of 11 essential minerals in the 234 Total Diet Study foods; one report concerns dietary intake estimates of the 11 minerals for eight age-sex groups; and one report concerns the contributions of 12 food groups to mineral intakes for these age-sex groups. The food list and diets of the Total Diet Studies were revised in 1991 based on data from the 1987-88 USDA Nationwide Food Consumption Survey. Since the revision in 1991, there have been eight collections of the 265 foods. The foods of each collection are analyzed for 10 essential minerals, and for one collection each year, the foods are analyzed for folic acid and vitamin B-6. A special project was initiated with the USDA Human Nutrition Research Center on Aging at Tufts University on the vitamin K content of foods and daily intakes of this nutrient. FDA sent samples of each of the 265 foods (from one collection) to the Vitamin K Laboratory at Tufts University for analysis. Estimates of the vitamin K intake of 14 age-sex groups have been completed based on these data.

International Interface Standard

Work on the International Interface Standard continues under a contract with Technical Assessment Systems (TAS) in Washington, DC. The purpose of the Interface is to enhance exchange and sharing of food-related information among database users and developers by allowing for clear and unambiguous descriptions of foods. The Interface allows for foods to be described from a variety of viewpoints (factors). Standardized terms have been developed and used for the factors. The schema (template) for food description has been completed. The contractor is currently developing the software for computerized use of the schema. The projected completion date for the project is April 1995.

Database for the Nutrition Labeling of Raw Produce and Fish

A proposal was issued in the Federal Register of May 1994 to update the guidelines for retailers for presenting nutrition labeling information to consumers for the 20 most frequently consumed raw fruit, vegetables, and fish. The proposal also updated the nutrition labeling values for these foods. The original guidelines and labeling values had been published by FDA in the Federal Register of November 27, 1991 (final rule for the Voluntary Nutrition Labeling Program). The listings of the 20 raw fruits and vegetables in the proposal are the same as those in the November 21, 1991 final rule. However, several changes were made to the fish list (e.g., swordfish and subspecies for salmon were added). Changes in nutrition labeling values (from the November 21, 1991 final rule) include revised values for bananas based on data from the

International Banana Association, newer data on tangerines from the Produce Marketing Association, use of USDA data for European grapes (rather than American grapes), and application of FDA compliance calculations to USDA data for several produce items and for fish. Other changes were made to the labeling information for raw produce and fish to be consistent with the mandatory nutrition labeling regulations which were issued on January 6, 1993. These changes concerned the presentation of mandatory nutrients, rounding of nutrient values, and use of percent Daily Values.

FDA Database Review System

Information on the FDA Database Review System was presented at another session.

Dietary and Nutritional Status of Americans: What the Nutrition Monitoring Program Shows

Debra A. Reed, HNIS, ARS, USDA

One purpose of the National Nutrition Monitoring and Related Research Act of 1990 is "to assess, on a continuing basis, the dietary and nutritional status of the people of the United States and the trends with respect to such status, the state of the art with respect to nutrition monitoring and related research, future monitoring and related research priorities, and the relevant policy implications."

We've heard in numerous presentations over the past three days how nutrient databanks and the national nutrient databank affect this purpose of the act, and the ability of the nutrition monitoring program to assess the nutritional status of the population.

Reports and publications provide a major contribution to addressing this purpose. Several publications have been produced under the auspices of the Interagency Board for Nutrition Monitoring and Related Research. The Board, which directed the development and oversees coordination of the Ten-Year Comprehensive Plan for Nutrition Monitoring, is comprised of representatives from 22 Federal agencies.

What I will do now is briefly review recent publications produced, and update you on publications underway and in planning. My intent is to not only familiarize you with what is available, but also to show you how the publications interrelate, and the significant differences between them. As users of data from the Nutrition Monitoring Program, you constitute a primary audience of Program publications, and we would like to have your input about them. We would like to know if they serve their purpose, or whether you may have suggestions for improvements or modifications that would be useful for your needs.

Major Board publications to date have included the *Directory of Federal and State Nutrition Monitoring Activities*; the *Scientific Reports* to Congress, of which there have been two; the National Nutrition Monitoring *Chartbook*; and miscellaneous technical reports, such as budget and progress reports to the President and Congress.

The *Directory of Federal and State Nutrition Monitoring Activities* is a resource guide to research activities in the Nutrition Monitoring Program. The Directory is a valuable reference tool, and provides information on surveys and research activities, including the purpose, target population, and survey design, for example. Each Program activity listed includes a contact person and agency.

The *Directory* was first published in 1989, and a revised edition was published in 1992. The original strategy was to publish the *Directory* every 3 years, but we are currently considering changing this to every 5 years. It is our thought that the activities represented in the *Directory* do not change rapidly enough to warrant the significant time and resources necessary to revise the publication every 3 years. Therefore, we believe that a five-year update would be adequate. Please let me know if you think otherwise, or if you have any suggestions for future *Directories*.

Scientific reports to Congress every 2-5 years are a mandate of the 1990 Act. Specifically, the Act calls for the government to contract with an independent scientific body, such as the National Academy of Sciences or the Federation of American Societies for Experimental Biology (FASEB), to interpret available data analyses and publish a report on the dietary, nutritional, and health-related status of the people of the United States, and the nutritional quality of food consumed in the United States.

Two such scientific reports have been produced to date: the first in 1986, and the second in 1989. Production of the Third Scientific report is now underway, and I will further discuss this in a few minutes. First, I'd like to describe a publication that is being produced interim to the scientific reports, the *Nutrition Monitoring Chartbook*.

The first chartbook on nutrition monitoring was published in September 1993. The *Chartbook* is not a mandated publication, but is a stated activity in the Ten-Year Plan. It originated based on the results of a survey of data users, particularly users of the scientific reports. The results of this survey showed that individuals wanted a more "user-friendly" source of information from the nutrition monitoring program--they suggested the use of more interpretive graphics, and less text in publications. They also wanted to be able to locate specific topics easier than past reports allowed.

The results of these suggestions have been two-fold. First, the Chartbook will be produced on a regular basis, interim to the scientific reports--every 3-5 years. Second, the format of the third scientific report will be somewhat different than the first two. I will discuss these changes in a few minutes.

Chartbook I was the first chartbook to be produced by the Board, and contains 64 one-page reports from across the nutrition monitoring program. The reports do not tell a story about the Program--they provide snapshots of specific activities or research. The focus of each report is one or two graphical charts, accompanied by brief explanatory text. Of most interest to this audience would probably be the section entitled "Food Composition and Nutrient Databases." This is one of five sections in the chartbook, and the fact that it accounts for 10 percent of the reports included is indicative of the increasing prominence and attention food composition data and nutrient databases are receiving in the Program. I would be glad to provide a copy of the Chartbook to anyone who has not received one; please leave me your business card or something with your name and mailing address. We would like to hear your impressions of the chartbook. The next one will be produced after the Third Scientific Report, probably in 1997 or 1998.

As I indicated, the scientific reports mentioned are much more comprehensive than the Chartbook--they do tell a story, not only about the data, but about the extent to which the Program is able to monitor the health and nutritional status of the entire U.S. population. One of the objects of the report is to identify gaps or weaknesses in the Program. Differences in the reports, from the first to the third, show the extent of the progress made in the Program, in terms of monitoring capabilities and improvements in coordination and comparability across Federal and state governments. For example, if we look at the data sources that were used in production of the first two reports, and that are being used currently to produce the third report, we see evidence of significant progress.

The first scientific report, published in 1986, included data mainly from USDA's Nationwide Food Consumption Survey (NFCS) and DHHS' National Health and Nutrition Examination Survey (NHANES). The report represented the first time that data from these two major cornerstones of the nutrition monitoring program had been examined so thoroughly in concert. It was also the first extensive effort to integrate these data into a single evaluation of the nutritional status of the population. In the process of examining the data, the effort helped to identify the strengths and weaknesses of these major surveys in measuring the nutritional and health status of the population. It also highlighted certain problems of comparability, such as differences in sample designs, and the use of different age groupings for reporting and analyses. These differences limited the ability to compare the data and to draw conclusions across them.

Since the first (1986) report, the NNMRRP has become more integrated. The reporting of data and the coordination and comparability of data have been improved.

As shown in this slide, while the primary data sources--the major surveys--remained essentially the same, 8 additional surveys and surveillance systems were used as data sources for the second (1989) report. Even more significant is progress reflected in the data sources for the Third report. The two nationwide surveys are still the primary data sources, but comparability between the two has improved, as well as among the 35 additional data sources contributing to the evaluation.

Eleven Federal agencies have provided data for analysis and interpretation by the contractor, from the Departments of Agriculture, Health and Human Services, Defense, and Labor. A total of 1500 data tables has been delivered to the contractor to date, and certain additional re-analyses have been requested by LSRO and the Expert Consultants who are contributing to production of the report.

Production of the 3rd report began in September 1993, when a contract was competitively awarded to the Life Sciences Research Office (LSRO) of the FASEB. LSRO also produced the second scientific report. LSRO staff primarily involved in report production are Dr. Ken Fisher, the Director of LSRO, and Dr. Sue Anderson, Associate Director; and Janet Waters, LSRO Staff Scientist.

LSRO has convened a group of 8 expert consultants and one alternated to examine and interpret the data for report production and analyses. The consultants were chosen for their expertise in disciplines essential to the Program and the evaluation underway. Dr. Kent Stewart is the consultant with expertise in food science and technology who provides expertise to the panel in the area of food composition and related issues.

The specific charge to LSRO for production of the Third Scientific Report is to: (1) build on the foundation, philosophical approach, and intent established in the first report (1986) and further developed in the second report (1989); (2) conduct a scientific review and assessment of data and information available through the NNMRRP, on the nutritional status of Americans, and the nutritional quality of food consumed in the United States; and (3) deliver the findings, conclusions and recommendations in two reports--a comprehensive report, and a separate executive summary.

Based upon the findings of the user's survey I briefly discussed, we have asked LSRO to change somewhat the format of this report. Compared to the first two, it will utilize graphics and charts to a greater extent; text will be briefer; and we are considering printing the report in two colors, rather than black and white. Extensive use of cross-referencing and indexing will be used to assist readers looking for specific information. Data tables will appear in appendices for reference.

Also contributing to the comprehensiveness of the report and its conclusions is the fact that, to the extent possible, all data contributed was run using comparable demographic and cut-off variables, as recommended by a working group of USDA and HHS staff. That is, the same age groupings were used; definitions and cut-offs for poverty and income were standardized; guidelines for reporting data by race and ethnicity were standardized, and statistical and reporting guidelines were issued for data analyses.

Another major difference in this report will be its organization. The report outline developed by LSRO and Expert Consultants, which has received approval by the Steering Committee for the Third Report, is based on the conceptual model shown in this slide. Note that highlighted areas are the 5 component areas of the NNMRRP; much of data will concentrate on these areas. Some of the other areas listed here are also becoming increasingly important, such as away-from-home food--both economically and nutritionally accounting for more of our diets today than at any time in the past. Supplement use is also an area receiving greater interest, and has been a topic of discussion among the consultants.

I will briefly go through these major component areas and review some of the topics that have been discussed by the consultants in their meetings to date. These areas will likely be focal points in the Third Report. To date, the consultants have had 4 2-day meetings in Washington, beginning in November of 1993. All members were present at these meetings, and they entailed methodical reviews of available data by sources, with some cross-comparisons of similar data from other sources. Just this month they began meeting in smaller groups, to concentrating on specific topics of interest according to their areas of expertise.

In the area of Food Composition, Dr. Stewart has led discussions, focusing on many of the topical areas that Betty mentioned on Sunday as heavily influencing database activities at this time. For example, methods for imputing nutrient values based on similar foods, and even the relative contribution of imputed nutrient values to total nutrient intakes of individuals in the food consumption surveys. The interrelationship of the HNIS data base systems, which Betty showed a graphic depiction of, has also been discussed. We are encouraged by the discussions to know that the area of food composition and nutrient data bases will receive greater attention and bigger play in the third scientific report and future reports, and we are looking forward to this particular section in the 1995 report. Hopefully, many of the issues being discussed here at this conference will be addressed, or receive recommendations for future activities.

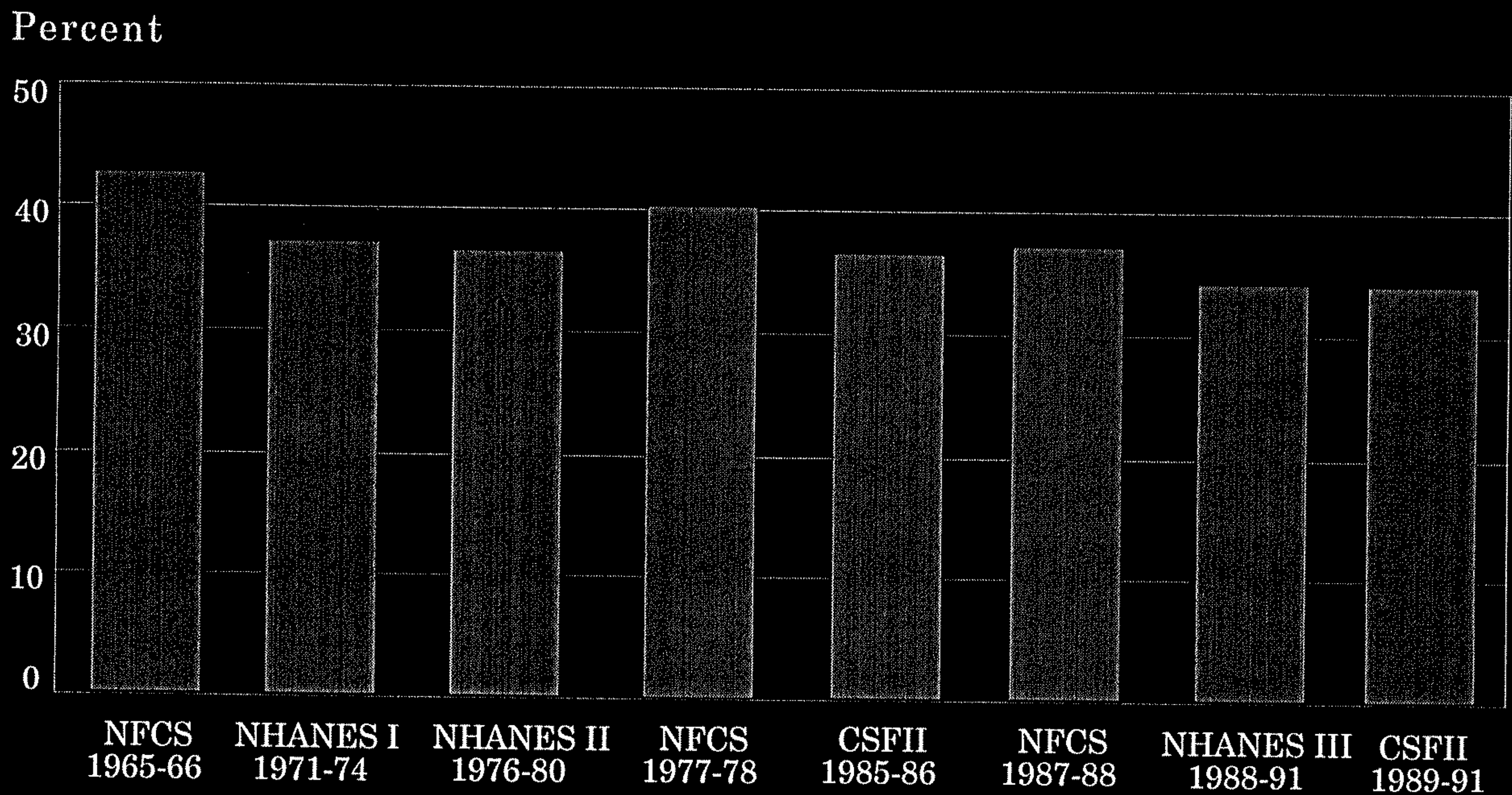
In the area of food and nutrient consumption, intakes of food energy and dietary fat have received some attention. As shown by this slide, the nationwide surveys have shown gradually decreasing intakes of fat as a percent of total calories since the mid 1960s. The 1965-66 NFCS estimated mean fat intakes at a little over 40 percent of calories, and the latest surveys, the CSFII 1988-91 and the NHANES III, Phase One, both show mean one-day intakes of the population at about 34 percent of calories.

If we look back at the area of Nutrition and Related Health Measurements, overweight is a topic of interest. Overweight was identified in the first and second scientific reports as an issue of public health significance. The first report estimated that the prevalence of overweight in surveys conducted in 1960-62, 1971-74 and 1976-80 showed that about 28 percent of the adult population was overweight. In all three surveys, the prevalence was higher among females than males, and highest among black females. In the second report, HHANES (1982-84) was the only source of new data since the 1st report, and this showed a high prevalence of overweight in three hispanic groups - from 26 to 42 percent. Again, the prevalence was higher in females than in males across all age groups. Not surprisingly, data contributed to the latest report show an increase still in the prevalence of overweight in adults of all ages, especially among females.

Serum cholesterol levels are another topical area. Data released from NHANES III show an overall drop in mean serum cholesterol levels. Trends in hypertension and growth/stunting in children have also received a lot of attention, and will likely be covered in the report. Finally, a recently expanded role for the monitoring program--knowledge, attitudes, and behaviors. The consultants have lately focused on data from the Diet and Health Knowledge Survey, or DHKS, and similar data available from the Health and Diet Survey, for example. As we heard on Sunday from Dr. Stillings and Dr. Sherr, there is more concern from consumers, and presumably greater awareness, about the nutritional quality of their diets, and the effects of diet on health. The consultants are looking for behavioral effects linked to awareness and attitudes. Some of the links, for example, between fat intakes and associated health outcomes, seem more apparent to consumers than others.

A first draft of the Third Scientific report will be presented to the Steering Committee and members of the Interagency Board on August 1 of this year. The final report will be published in 1995. At present, we are considering developing slide packages of selected topical areas for availability of data users such as yourselves. We invite your feedback on whether slides would be of utility to you. Please feel free to contact me about this or any of the other items I have mentioned. Thankyou, and I will answer any questions that I can.

Percent of Food Energy From Dietary Fat



(1-day intakes)

1779/6-213

Update on the Third National Health and Nutrition Examination Survey

Margaret A. McDowell, Centers for Disease Control and Prevention

The NHANES Program

I am pleased to provide an update on National Health and Nutrition Examination Survey (NHANES) program activities. My presentation includes findings NHANES III-Phase 1 (1988-91) as well as plans for future reports and data release.

The National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) conducts periodic surveys to assess the health and nutritional status of the U.S. population. NHANES data are obtained by means of interview and examination methods. Two surveys were completed by NCHS between 1971 and 1980--NHANES I, 1971-75 and NHANES II, 1976-80. NCHS completed a special HANES of three Hispanic subgroups--Hispanic HANES between 1982-84. NHANES III is a six-year survey of the U.S. population. Data collection for this survey began in October, 1988 and will end in October, 1994. NHANES III is divided into two 3-year phases; each phase constitutes a national sample. Data for the entire six year survey may be combined to form a larger national sample.

The objectives of NHANES III are to collect national health and nutrition data to estimate the prevalences of selected diseases and risk factors, to prepare reference data for a wide range of health parameters, to examine secular trends in the prevalences of disease and health risk factors, and to collect data which are needed to study the etiology of chronic diseases. Several methodologic improvements and planning considerations were incorporated into the design of the Survey to permit tracing and longitudinal follow-up of NHANES III respondents (1,2).

The NHANES III respondent universe

The NHANES III sample is comprised of more than 40,000 persons 2 months of age and older. Of these, approximately 35,000 will complete the interview portion of the Survey, and 30,000 persons will be examined in mobile examination centers (MEC). The NHANES III sample is comprised of the civilian, noninstutionalized population of the United States. The Survey's stratified, multistage probability sample design includes an oversampling of children, older persons, African Americans, and Mexican Americans so that reliable estimates of health status indicators will be available for these population subgroups (3).

Data collection

The data collection contractor for NHANES III is Westat Inc. of Rockville, MD. The contractor completes the advance arrangements for each Survey location or "Stand". This entails setting up field offices and the MEC, hiring and training MEC and field office staff, preparing training manuals, organizing staff retraining, implementing quality control procedures, and transmitting data to NCHS.

Advance letters are mailed to prospective Sample Persons (SPs) informing them that an interviewer will visit their home. If household members are eligible and willing to participate in the Survey, family and household interview questionnaires are administered in the home. Approximately one month after the household interview, respondents complete the examination component in the MEC. Examinations are scheduled during morning, afternoon and evening hours. Examinations are conducted all days of the week. SPs are compensated for participating in the examination component.

The NHANES III Dietary Assessment Component

NHANES data are used to estimate the prevalences of nutrition-related risk factors such as overweight and poor diet, to provide data to examine the relationship between diet, nutritional status, and health, and to provide baseline data to relate long-term dietary practices to chronic diseases. Anthropometric, biochemical and hematologic, dietary, and clinical data are collected. The dietary assessment component includes 24-hr dietary recall and food frequency interviews. Information is obtained on the use of vitamin and mineral supplements, medications, alcohol, drinking water, and salt.

The food frequency questionnaire is targeted to collect more detailed information on dietary sources of calcium, caffeine, and vitamins A and C. Sample Persons (SP) 12+ years of age are eligible for the food frequency interview. SPs 17+ years of age complete the food frequency interview during the household interview; adolescents 12-16 years of age complete the food frequency interview in the MEC. A separate infant food frequency questionnaire is administered during the household interview.

All NHANES III examinees are eligible for the 24-hr dietary recall interview. Interviews are collected in the MEC by trained, bilingual dietary interviewers. Proxy respondents report for infants and young children and respondents who are unable to report for themselves. The dietary interviewer's training manual provides a detailed description of the NHANES III dietary protocol (4).

NHANES III Dietary Recall Data Collection

An automated dietary interview and coding system was used to collect all NHANES III 24-hr dietary recalls. The NHANES III Dietary Data Collection (DDC) system was developed by the University of Minnesota's Nutrition Coordinating Center (NCC) with NCHS, National Heart, Lung and Blood Institute, and Food and Drug Administration funds. The features of the DDC system include the capability to conduct open-ended interviews using structured probes to ensure standardized data collection (5). Updated versions of the DDC system were installed in the field throughout NHANES III. All foods and beverages reported during Phase 1 were coded using the USDA Survey Nutrient Database (6).

Quality control monitoring of dietary data collection

Quality control monitoring for dietary interview component includes direct observations of interviews in progress by NCHS, Westat, and supervisory staff, reviews of printed recall reports, reviews of taped recall and food frequency interviews, and a ten percent cross-check of printed recall reports by a second dietary interviewer. Communication with field staff is maintained by means of telephone calls to the interviewers, field memoranda, newsletters, interviewer training manual updates, and dietary interviewer retraining activities.

NHANES III Response Data

Final interview, examination and component response data for NHANES III-Phase I (1988-91) are shown in Tables 1 and 2. A total of 20,277 persons were identified for the Phase 1 sample. Of these, 17,464 (86%) were interviewed and 15,630 (77%) were interviewed and examined. During Phase 1, a total of 15,409 examinees (99% examinees) were interviewed by a dietary interviewer.

The Phase 1 analytic sample is comprised of examinees who had complete and reliable recalls. Of the 15,409 SPs who were interviewed by the dietary interviewers, 14,801 SPs had reliable and complete dietary recalls. The Phase 1 24-hr dietary recall component response rate was 95% (14,801/15409) and the overall analytic response rate was 73% (14,801/20,277).

Nursing infants and children were excluded from the analytic sample because NCHS did not attempt to quantify human milk intake. Individuals with incomplete (n=338) or unreliable recalls (n=100) were also excluded. NCHS did not impute missing data. A small number of recalls (n=29) were lost due to a computer problem which was unrelated to the dietary interview system. A total of 221 examinees did not complete dietary interviews for various reasons such as refusals, illness, and lack of time.

Earlier this year, NCHS produced the NHANES III-Phase 1 total nutrient intake data file. NCHS reported total mean energy and percentages of energy intake from total fat and saturated fat in the February 25th issue of the CDC Morbidity and Mortality Weekly Report (7). Highlights of this report and a paper presented by Dr. Ronette Briefel at the Nineteenth Beltsville Symposium are shown in the next series of slides (8).

Mean energy intakes for males and females by age are shown in Figure 1. Mean energy intakes were higher for males, compared to females in all ages. Energy intakes peaked during adolescence and early adulthood, and declined thereafter. The mean energy intake for males 2 years of age and older was 2518 kcal, and for females 2 years of age and older, 1751 kcal. Mean energy intakes are similar to recommended intakes based on 1989 Recommended Dietary Allowances for males through age 40 years, and for females through age 12 years (9). The Phase 1 reported energy intakes for males over 40 years of age and females in their teens and beyond fall below the recommended intakes.

Sources of food energy for males and females 20 years of age and older are shown in Figure 2. Carbohydrate provided 48% energy (%kcal) in males and 50 %kcal among females. Fat provided 34 %kcal in males and females. This figure is lower than the 36 %kcal from fat which was reported in earlier national surveys conducted in the 1970's and 1980's. Approximately fifteen percent of total energy intake was supplied by protein for males and females. Alcohol accounted for 4% total energy intake of males and 2% in females. Alcohol intakes are often under-reported in surveys, but the collection of weekend recall data, and use of a private dietary interview setting in the MEC improves alcohol information in NHANES. The only difference in the sources of energy by race/ethnicity group is that fat contributed a lower percentage of energy intake in Mexican Americans--32.8 %kcal overall versus 34 %kcal for the other race-ethnicity groups.

The variability in mean energy intakes by day of the week was examined. Differences were found between males and females (Table 3). Males had higher energy intakes on Fridays, Saturdays and Sundays, depending on the age groups. For females less than 60 years of age, mean energy intakes were highest on Friday and Saturdays. Mean energy intakes were highest on Wednesdays and Sundays for females 60 years of age and older.

Mean energy intakes reported during NHANES II (1976-80) and NHANES III-Phase 1 were compared (Table 4). There was little change in the mean energy intakes of persons less than 12 years of age between surveys. For all age groups 12 years of age and older however, the NHANES III energy intakes were higher. Among males 12+ years of age, mean intakes were 1-13% higher; for females, mean intakes were 1-17% higher.

One objective of HANES is to look at secular trends in the U.S. population. Interpretation of trends in energy and nutrient intakes is difficult when methodologic changes occur between surveys. Many factors must be considered when interpreting changes in mean energy intake between NHANES II and NHANES

III. For example, significant improvements were made in the dietary interview methods and quality control monitoring for NHANES III to improve the completeness of the 24-hr recalls. NHANES III includes all days of the week, whereas NHANES II had few weekend days. The improved coverage on weekends probably affected alcohol estimates as well. Finally, different food coding and food composition data bases were used in these surveys.

Several studies have addressed under-reporting of total food intake in dietary studies. In a long-term study conducted by Mertz et al., reported food energy intakes were on average, 18% lower than expected, based on body weight maintenance requirements (10). Under-reporting during NHANES III was investigated using measured body weight and reported food intake data. The ratio of reported energy intake (EI) to the basal metabolic rate (BMR) was calculated using formulas published by Bingham (11). Ratio values of 1.50-1.55 are expected for sedentary populations (12).

EI/BMR ratios for adult males and females calculated by Black et al. using NHANES I and NHANES II data were compared to data for Phase 1 (13). The ratio values are higher for Phase 1 (Tables 5 and 6). The EI/BMR for males and females during NHANES III-Phase 1 are shown in Table 7. The ratio values declined with age for both sexes. Overall EI/BMR values were 1.47 for males and 1.27 for females. Within age-gender groups, the ratios did not differ by race/ethnicity group.

The EI/BMR ratios differed by overweight status. Ratios were computed for persons defined as overweight using a BMI of $\geq$ 27.8 for males and $\geq$ 27.3 for females. The EI/BMR ratios for overweight persons were significantly lower than those computed for the total population (Table 8). Overweight males had a ratio of 1.28 compared to a value of 1.47 for all males. The ratio for overweight females was even lower--1.1 in overweight females vs 1.27 in all females.

Additional research is planned to identify the characteristics of population groups which tend to under-report. For example, there may be differences in the numbers, types, and quantities of foods reported by these groups. NCHS will also compare Phase 1 energy intakes reported during Phase 1 to findings from NHANES III-Phase 2 (1991-94) which will end in October. The same data collection methods and comparable databases were used in both Phases of NHANES III.

NCHS Data Release and Reporting Activities

For the remainder of my talk I will describe reporting and data preparation activities underway at NCHS. The NHANES III laboratory methods and plan and operations manuals will be available later this year. NCHS will also release a series of NHANES III dietary reference reports this year. The first Phase 1 data files scheduled for release to data users are the Household Questionnaire and total nutrient intakes data files. The Household Questionnaire dataset includes food frequency data for persons 17 years of age and older.

In the past, HANES data were released exclusively in data tape format. Data tape formats will be available, but NCHS also plans to release Phase 1 files in CD-ROM format through the NCHS Statistical Export and Tabulation System (SETS). SETS access software is used by data users to analyze CD-ROM datasets. The NCHS Data Dissemination Branch offers technical assistance in using the SETS software and CD-ROM datasets. Data users may telephone (301)-436-8500 to obtain additional information.

CDC maintains an online computerized information system called "Wonder/pc". Currently, this system is used to download public health and census data directly to a personal computer from the CDC mainframe computer center in Atlanta, GA. NCHS is exploring the possibility of adding NHANES datasets to the Wonder/pc database system.

Finally, let me call your attention to the NCHS Data Users Conference which will be held in Bethesda, MD from July 20-22, 1994. Representatives from NCHS and the CDC computer facility in Atlanta will attend this meeting. This meeting will provide NCHS data users with the most current information about NCHS data files and data analysis software.

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Table 1

24-hr dietary recall response rates

	Number	*24-hr recall*	*Survey*
Total sample persons	20,277	---	100%
Interviewed in home	17,464	---	86%
Examined in MEC	15,630	100%	77%
24-hr recall	15,409	99%	---
No 24-hr recall	221	1%	---
Reliable - complete	14,801	95%	73%

SOURCE: CDC\NCHS, NHANES III, Phase 1, 1988-91

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Table 2

24-hr dietary recall response rates

	Number	*Percent*
Reliable 24-hr recall		
Complete	14,801	95%
Incomplete	338	2%
Nursing infant/child	141	1%
Unreliable 24-hr recall	100	< 1%
Computer malfunction	29	< 1%
No 24-hr recall interview	221	< 1%

nchs

SOURCE: CDC/NCHS, NHANES III, Phase 1, 1988-91, N=15,630

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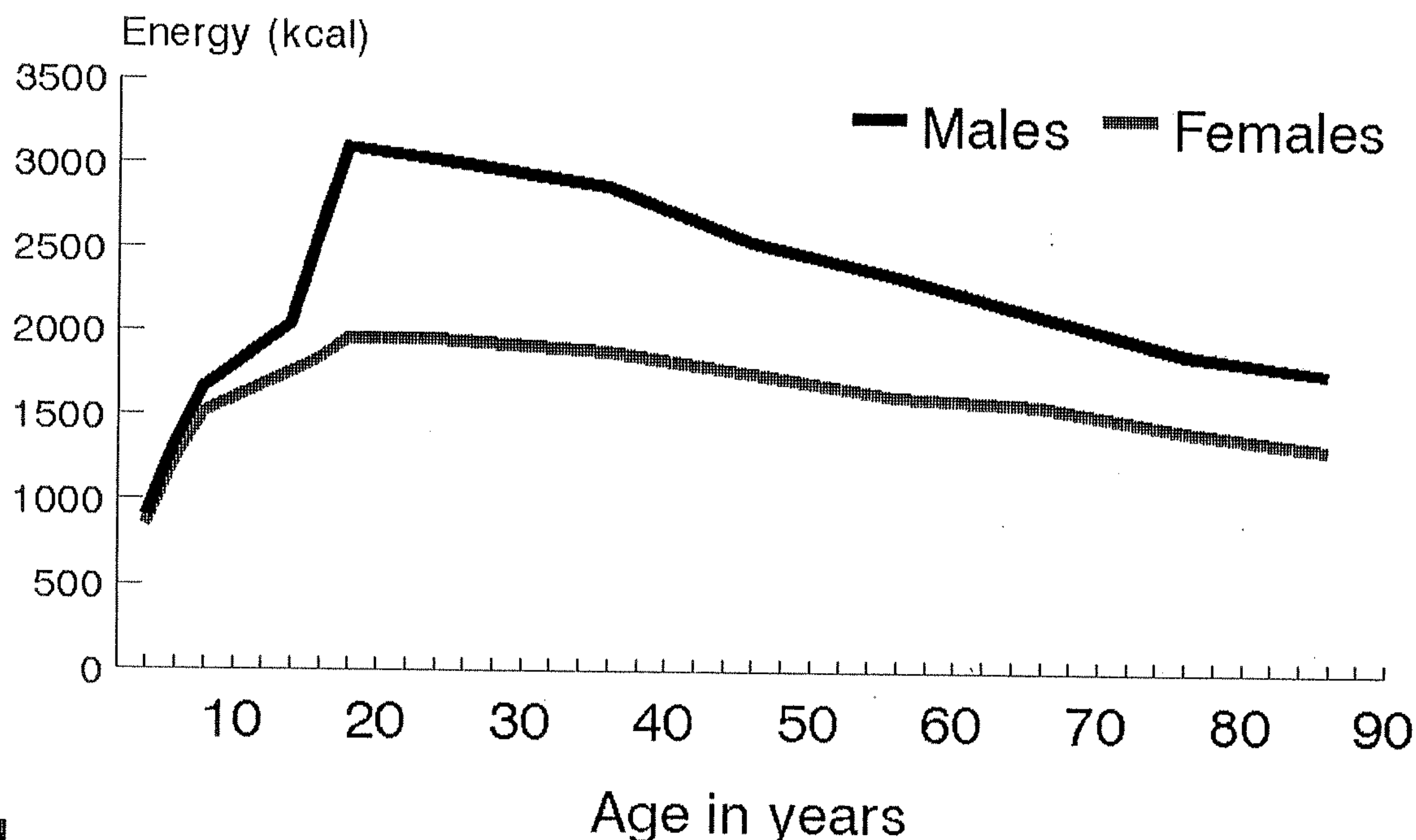
Figure 1

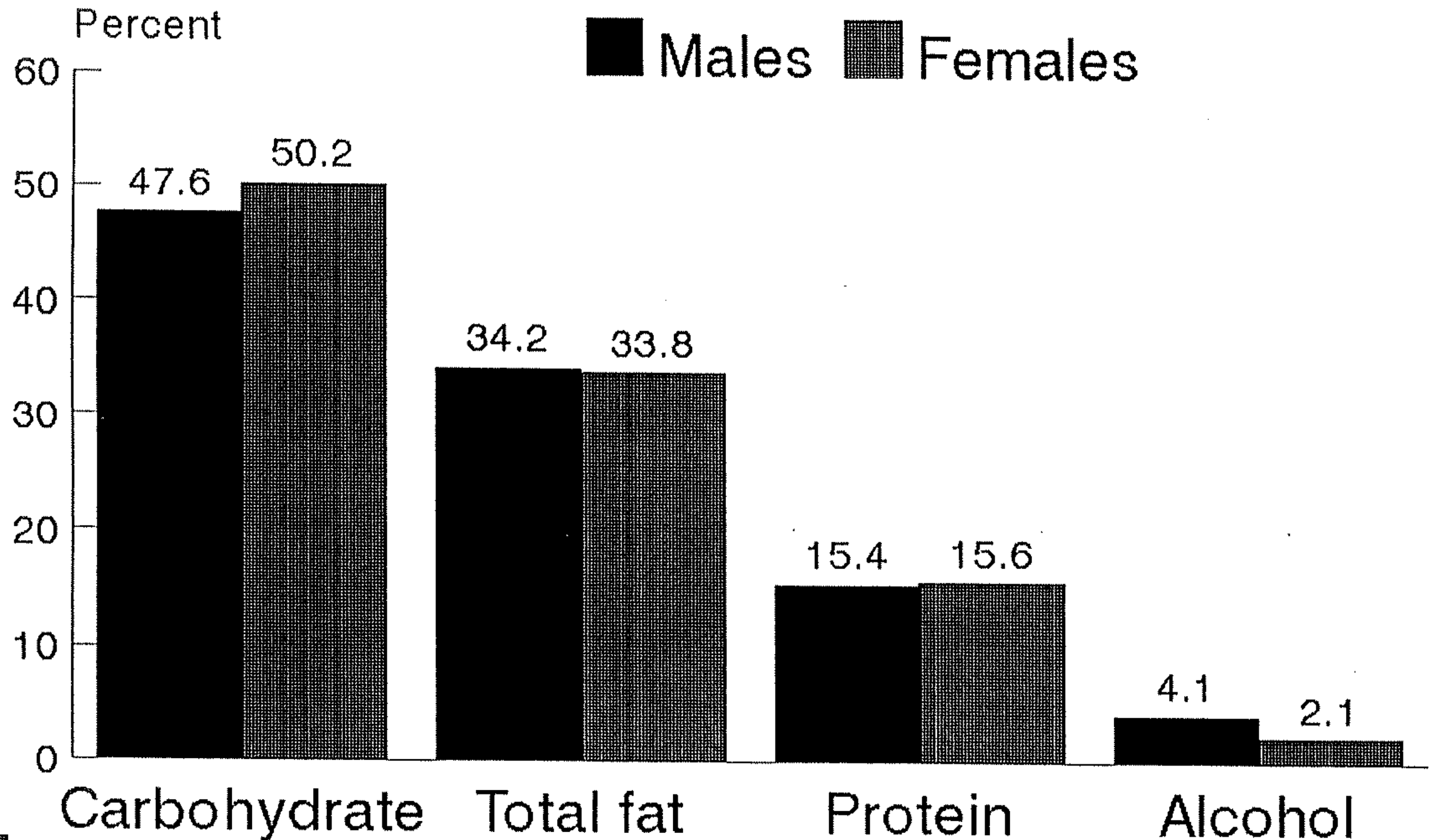
Mean energy intake



SOURCE: CDC/NCHS, NHANES III, Phase 1, 1988-91
24-hour dietary recall, 1 day, N=14,801

Figure 2

Sources of food energy: Adults



SOURCE: CDC/NCHS, NHANES III, Phase 1, 1988-91
24-hour dietary recall, 1 day, N=7931 ages 20+ years

Table 3

Day-of-the-week with highest reported mean energy intakes

Males	
2 mos.-19 years	Saturday, Sunday
20-59 years	Friday, Saturday, Sunday
60+ years	Friday, Sunday
Females	
2 mos.-19 years	Friday, Saturday
20-59 years	Friday, Saturday
60+ years	Wednesday, Saturday

NCHS

SOURCE: CDC/NCHS, NHANES III, Phase I, 1988-91
24-hour dietary recall, 1 day, N=14,801

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Table 4

Change in mean energy intake between 1976-80 and 1988-91

Age in years	*Males*	*Females*
12-15	+ 3%	< 1%
16-19	+ 1%	+16%
20-29	+ 4%	+16%
30-39	+12%	+17%
40-49	+ 5%	+15%
50-59	+ 6%	+14%
60-69	+ 7%	+17%
70-74	+13%	+16%

nchs CDC/NCHS, NHANES II and NHANES III, Phase 1
24-hour dietary recall, 1 day

CDC

Table 5

Ratio of reported energy intake to basal metabolic rate in adult males

Age in years	*NHANES I* (1971-74)*	*NHANES II* (1976-80)*	*NHANES III (1988-91)*
25-34	1.45	1.46	1.62
35-44	1.42	1.35	1.50
45-54	1.31	1.32	1.35
55-64	1.06	1.17	1.29

***Black et al, Eur J Clin Nutr 1991, 45:583-99**

SOURCE: CDC/NCHS, NHANES III, Phase 1, 1988-91

Ratio of reported energy intake to basal metabolic rate in adult females

Age in years	*NHANES I* (1971-74)*	*NHANES II* (1976-80)*	*NHANES III (1988-91)*
25-34	1.15	1.15	1.35
35-44	1.09	1.14	1.30
45-54	1.10	1.03	1.18
55-64	0.99	1.01	1.16

***Black et al, Eur J Clin Nutr 1991; 45:583-99**

SOURCE: CDC/NCHS, NHANES III, Phase 1, 1988-91

Table 7

Ratio of reported energy intake to basal metabolic rate in NHANES III

Age in years	*Males*	*Females*	*Total*
20-29	1.64	1.38	1.51
30-59	1.45	1.26	1.36
60+	1.32	1.18	1.24
Total	1.47	1.27	1.37

SOURCE: CDC/NCHS, NHANES III, Phase 1, 1988-91
24-hour dietary recall, 1 day, N=7904

Table 8

Ratio of reported energy intake to basal metabolic rate in overweight* adults

Age in years	*Overweight* males*	*Overweight* females*	*Overweight* total*
20-29	1.41	1.10	1.25
30-59	1.29	1.11	1.19
60+	1.17	1.05	1.10
Total	1.28	1.10	1.18

***BMI ≥27.8 for males and ≥27.3 for females, N=2938**

SOURCE: CDC/NCHS, NHANES III, Phase 1, 1988-91

Continuing Survey of Food Intakes by Individuals and Diet and Health Knowledge Survey

Lori Borrud, USDA-ARS-HNIS

These are exciting times for those of us working on USDA's nationwide food surveys: Fieldwork is successfully under way for our newest surveys--the 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII) and Diet and Health Knowledge Survey (DHKS) and results from CSFII and DHKS 1989-91 are in.

The USDA nationwide food surveys are a major component of the National Nutrition Monitoring and Related Research Program, or NNMRRP, created by legislation in 1990. The purpose of the NNMRRP is to monitor the dietary and nutritional status of the U.S. population and trends in such status.

The USDA has been conducting nationwide food consumption surveys since the 1930's. Earlier surveys were primarily surveys of household food use. An individual intake component was added in 1965. In 1985, USDA initiated the CSFII to provide continuous information on the food and nutrient intakes of the U.S. population. The current, 1994-96, CSFII is the third in the series. The DHKS was initiated in 1989 as a telephone follow-up to the CSFII and is the first national survey designed so that data on individuals' attitudes and knowledge about nutrition can be linked to their food and nutrient intakes.

The two major objectives for the CSFII and DHKS are to

- measure the kinds and amounts of food eaten by the U.S. population, and
- measure people's attitudes and knowledge about food and diet.

The first objective addresses the requirements of the 1990 legislation and the NNMRRP for continuous monitoring of the dietary status of the U.S. population, including the low-income population.

For monitoring the dietary status of the population, the CSFII provides detailed benchmark data on foods eaten in order to determine the choices Americans make, to evaluate the nutrient content and nutritional adequacy of their diets, and to signal changes over time. USDA, other Federal agencies, the food and agriculture industries, private organizations, and academia also use the data in analyses supporting public policy, regulation, program planning and evaluation, education, and research. Some uses of the data, including those related to estimating pesticide exposure from foods, are becoming more important.

The DHKS addresses the second objective, which is intended to provide continuing information with which to assess relationships between individuals' knowledge and attitudes about dietary guidance and food safety, their food-choice decisions, and their nutrient intakes. Knowledge of psychosocial factors that influence dietary status is useful to nutrition educators for identifying ways to implement dietary guidance effectively; to food industry analysts for making marketing decisions; and to regulatory agencies in setting policy on food assistance, food labeling, and food safety programs. DHKS information on the use and understanding of food labels should be particularly relevant following passage of the National Labeling and Education Act of 1990 and the food labeling regulations that were an outgrowth of that act.

CSFII and DHKS 1994-96 are being conducted as the "What We Eat in America" survey under contract with Westat, Inc., of Rockville, Maryland. Since the conference last year, the CSFII 1994-96 pilot study has been completed. The study was conducted in 10 sites nationwide in late spring 1993. The pilot study evaluated all survey operations, which was critical since a number of changes were instituted for CSFII and DHKS 1994-96, including the use of on-line food coding through Survey Net and electronic data transmission. We also tested our revised questionnaire and data collection methods as well as the increased survey publicity instituted for this survey.

Pilot study results showed that specified response rates were met; the length of the interviews did not exceed that specified for the pilot study; Survey Net met our high expectations for performance and quality data; and the weekly electronic delivery of survey data was successful. Data collection for the survey began in January of this year.

CSFII/DHKS 1994-96 was designed to provide a multistage stratified area probability sample representative of the 50 States and Washington, DC, with weighted estimates for each survey year and for all three years combined. A subset of the total sample will consist of individuals from low-income households--those at 130 percent of the federal poverty threshold or below. We anticipate that between 15,000 and 16,000 individuals will provide 2 days of intake data over the three years.

HNIS has made several important changes in survey design for CSFII and DHKS 1994-96. For these surveys we implemented changes that we believe will reduce respondent burden, raise response rates, and provide high quality data in a timely manner. We are collecting 2 days of dietary intake data by in-person interviews 3-10 days apart, but not on the same day. Previously we had collected 3 consecutive days of data, 1 day by interview and 2 days by respondent-administered food record. The change in data collection methods reduces the burden on respondents and provides 2 days of independent dietary intake data for use in estimating distributions of usual intake. Days of intake are to be spread across the seven days of the week, over the weeks of the months, and over the months of the year.

For the current CSFII we are no longer interviewing everyone in the household, but are sampling for selected individuals within the household. This not only reduces the burden on the household but allows us to obtain the intake data needed to meet stated precision requirements for each of 20 age-sex groups. With this sample design we will be collecting intake data on larger numbers of children and elderly than in previous surveys. Rather than conducting a separate low-income survey in 1994-96, we are oversampling the low-income population.

DHKS data are collected through a follow-up telephone interview 2-3 weeks after the dietary interviews. For the 1994-96 survey, DHKS data will be collected from a selected CSFII respondent in each household who is 20 years of age or older. Previously, DHKS data were collected from the main meal planner/preparer only. Survey operations also include the administration of a household questionnaire.

The current CSFII and DHKS feature many improvements in survey monitoring and data management to improve the timely release of quality data. The process starts with HNIS carefully monitoring the timeliness of the data collection efforts by reviewing weekly status reports of field work produced by the contractor's automated field management system. Monitoring continues with a review of weekly status reports from an automated forms tracking system detailing the number of questionnaires received, processed, and transmitted to HNIS by the contractor. In order to monitor the quality of the data and provide timely intervention, HNIS requires the contractor to transmit the survey data electronically each week.

Many of the changes implemented have been in the area of improved communication and information exchange. Examples are publicizing the survey to potential respondents, receiving survey data as well as status reports weekly, and increasing both the level and frequency of communication between HNIS and contractor staff. Through these types of changes, we can identify problems early and take corrective action.

HNIS has put forth a concerted effort to publicize the new survey and to provide the interviewers with the materials they need to convince people to participate in the survey. For example, we have developed a survey brochure that has been very well received. The brochure is mailed out with an advance letter to each household that will be screened prior to the interviewer's visit. The brochure includes an 800 number that potential respondents are encouraged to call if they have questions. We also have worked with our public affairs office and contractor to develop and mail out press notices on the survey to about 250 local newspapers nationwide and have been pleasantly surprised with the number of articles that have been printed.

Survey Net, our automated food coding and nutrient analysis program, has become an integral part of the communications network for the survey. Using Survey Net, HNIS can monitor the data received from the contractor, update the data base files accordingly when new foods are reported, and send the updated data base files electronically to the contractor. In other words, there is a continuous flow of information between HNIS and the contractor which we believe will speed the release of high-quality data.

As a data base management system, Survey Net allows other forms of communication in addition to that which takes place between HNIS and the contractor. Survey Net links coded food intake data from the CSFII to the National Nutrient Data Bank through the Survey Nutrient Data Base. It provides information on new foods and frequently reported foods. Finally, Survey Net generates and then uses the Survey Nutrient Data Base for nutritional analysis of the food intake data. Analysis of recipes reported in the survey is part of this process.

Survey Net is being further developed to operate with the new Nutrient Data Base for Trend Analysis. This data base will identify changes to the data base resulting from actual changes to foods or as improvements to the data. The trends analysis data base will allow us to revise consumption data from previous surveys to account for improvements in the nutrient values, thus increasing comparability in nutrient intake data from one time period to another.

Another important link is that between Survey Net and the Food Grouping System, another data base management system. Information on food is collected the way people eat it--as separate items such as a piece of chicken or as mixtures such as pizza. HNIS' Food Grouping System allows us to translate information on consumption to the specific ingredients or even to the level of raw agricultural commodities. This system is presently being used in limited applications to meet data requirements for USDA and other Federal agencies. We are working at this time to fully automate Food Grouping System operations. We are excited about the possibilities offered by Survey Net and the Food Grouping System as data base management system components.

I'd like to update you now on CSFII and DHKS 1989-91. Data tapes for all three survey years are available from the National Technical Information System. At this time, we are preparing a number of reports. These include the CSFII 1989-91 1-day and 3-day reports and the 1989-91 DHKS report. We also are working and are looking forward to providing these data on CD-ROM.

Plans for conducting the household food consumption survey in 1996 as reported last year have been postponed. While we are continuing to plan for the next household survey, at this time I cannot tell you definitely when that survey will be conducted.

I'd like to spend a few minutes telling you what we think are some of the most important trends from CSFII 1989-91. CSFII 1989-91 included the collection of 3 consecutive days of dietary intake data. The results presented here are, for the most part, from the first day of data collection from the 3 combined years--1989, 1990, and 1991.

One of the first things people want to know from survey data is how well our diets meet the Dietary Guidelines for Americans. Have changes in what we eat moved us closer to dietary recommendations made by science and health groups? The answer, of course, is yes and no.

The first Dietary Guideline is EAT A VARIETY OF FOODS. In 1989-91, Americans ate a wide variety of foods: For four of the five major food groups--grain products, vegetables, milk, and meat--the percentage of individuals eating at least one item from the group was 80 percent or more. For the grain products group, more than 96 percent of individuals ate at least one grain item. The fifth group, fruit, is a different story.

Diets in 1989-91 differed considerably from those reported in our 1977-78 nationwide food consumption survey. In 1989-91, we ate more of some types of grain products, especially cereals and pastas and grain mixtures such as pizza; we drank less whole milk and more lowfat and skim milk than a decade earlier; we ate more mixtures that were mainly meat, poultry, or fish (such as hamburgers and stews) and fewer separate cuts of beef and pork (such as steaks and roasts); we ate fewer eggs; and we drank more carbonated soft drinks, especially low-calorie ones. But overall fruit and vegetable consumption changed very little--despite dietary advice to eat more.

One of the more interesting trends, and one that affects the variety of foods eaten, is the increase in consumption of both grain mixtures and meat mixtures. HNIS has always collected food as individuals eat it. For reporting purposes, mixtures, such as pizza or stew, are assigned to the group of the main ingredient.

From the Food Grouping System, we now know that about 57 percent of grain mixtures are pasta-based, such as spaghetti with sauce, macaroni and cheese, or pasta soups; 32 percent are bread-based, such as pizza, enchiladas, burritos, and tacos; and 11 percent are rice mixtures. When these mixtures are broken down into their component parts, only about one-third of the weight of grain mixtures is a grain product, about one-fourth is vegetables, and about one-sixth is water. Milk products; meat, poultry, or fish; and other ingredients account for the rest.

Of mixtures that were mainly meat, poultry, or fish, about 67 percent are red meat, 15 percent are poultry, and 9 percent are fish. Meat or poultry soups account for the other 9 percent. Of the meat, poultry, and fish mixtures, about one-third of the weight is a meat, poultry, or fish item, about one-fourth is vegetables, and about one-sixth is grain. Water, milk products, and other ingredients account for the rest.

Another way to assess the variety of foods we eat is to look at how individuals fare with respect to their nutrient intakes. The wide array of foods consumed in 1989-91 provided the Recommended Dietary Allowance (RDA) for many nutrients but not for others. In general, average intakes for most population groups exceeded the RDA for protein, vitamin A, vitamin C, thiamin, riboflavin, niacin, folate, vitamin B-12, phosphorus, and iron. For other nutrients--vitamins B-6 and E, calcium, magnesium, and zinc--intakes were below the RDA for many sex-age groups. While the mean intake of iron is about the RDA, intakes by some sex-age groups (mostly women) were not. Although vitamin E and zinc were not examined in 1977-78, vitamin B-6, calcium, iron, and magnesium were also below the RDA a decade earlier.

The second guideline is MAINTAIN A HEALTHY WEIGHT. Obesity is a major health problem in the United States. It is linked with high blood pressure, heart disease, stroke, adult-onset diabetes, and certain cancers. The proportion of the population classified as overweight (based on self-reported height and weight) increased since 1977-78 by about 55 percent for adult males and abut 27 percent for adult females. About 3 percent of the overweight men and 11 percent of the overweight women reported that they were on a low-calorie or weight-loss diet.

Another guideline is CHOOSE A DIET LOW IN FAT, SATURATED FAT, AND CHOLESTEROL. Americans appear to be doing a better job of this. Over the past decade there has been a shift to a lower fat, higher carbohydrate diet. In 1989-91, individuals obtained 34 percent of their calories from fat, down from 40 percent in 1977-78. However, the amount of fat in the average diet is still higher than the 30 percent or less of calories recommended by the Dietary Guidelines for Americans. Neither saturated fat nor cholesterol were examined in 1977-78, but in 1989-91, saturated fat accounted for about 12 percent of calories, above the recommended level of less than 10 percent.

Many health authorities recommend a daily cholesterol intake of less than 300 mg. The average intake of cholesterol in 1989-91 was 270 mg--345 mg for men and 231 mg for women. Black males 20 years and over had higher cholesterol intakes (382 mg) than did white males 20 years and over (340 mg).

More lower fat products, leaner meat, and changes in food choices have probably contributed to the reduced percentage of energy from fat. For example, our intake of whole fluid fell by nearly a third--down 35 percent over the last decade while our intakes of lowfat/skim milk rose 111 percent.

CHOOSE A DIET WITH PLENTY OF VEGETABLES, FRUITS, AND GRAINS is the fourth Guideline. The average intake of grain products increased by 27 percent, intakes of cereals and pastas by 49 percent, and intakes of grain mixtures by 71 percent compared with 1977-78. Pizza is an item that illustrates the increased consumption of grain mixtures. The amount of pizza consumed tripled over the last decade. Children ages 6 to 11 are the biggest consumers, although all groups have increased their consumption.

Survey data showed that the average intake of vegetables declined by about 11 percent. However, vegetable intakes are underestimated because vegetables are frequently eaten as part of mixtures, such as carrots or potatoes in stews and tomatoes in sandwiches, casseroles, and pizza. We estimated that about one-fourth of the weight of both meat mixtures and grain mixtures are vegetables. Since the intake of mixtures has increased substantially over the last decade, we may assume that intakes of vegetables may not have declined as much as the data indicate. Use of the Food Grouping System will help us to determine this. However, there is no evidence to indicate that vegetable consumption is reaching the Food Guide recommendation of 3 to 5 servings daily.

Fruit consumption increased slightly over the decade. However, on the first day of the survey, almost half (47 percent) of the population ate no fruit and drank no fruit juices. The Food Guide advises individuals to consume 2 to 4 servings of fruit daily. For some groups, especially teens and young adults, the percentage eating no fruit is even higher. This is clearly one major area where Americans are not meeting the Guidelines. Vegetables and fruits are major sources of vitamins A and C in the diet. Although average intakes by all sex and age groups for both vitamins are above the RDA, the averages conceal variations. Research we did last year with 2 years of CSFII data showed that women who ate no fruit had intakes of vitamin C that were below the RDA and that were much lower than the average vitamin C intakes of women in general.

Average intake of fiber in 1989-91 was 14 grams. Men consumed more fiber (17 grams) than women (12 grams). Although the Dietary Guidelines make no recommendation on the amount of fiber that should be consumed, these levels fall well below the 20 to 30 grams recommended by the National Cancer Institute.

The next guideline is USE SUGARS ONLY IN MODERATION. Intakes of total sugars in the diet cannot be estimated from the CSFII at this time because the current survey nutrient data base does not include total sugar. The addition of total sugars to the data base is under review. Food supply data, however, suggest that sugar consumption is on the rise.

We do know that much of the sugar we eat is an ingredient in other foods, such as cookies or cakes, sweetened beverages, and other processed foods. This makes it difficult for people to know how much sugar they are actually consuming or to realize that their consumption of sugar is increasing.

In 1977-78 consumption of soft drinks was about two-thirds of the consumption of either milk or coffee. In 1989-91, however, average milk and coffee consumption was about the same or slightly less than a decade earlier, but soft drink consumption had increased by 72 percent.

The last two guidelines are USE SALT AND SODIUM ONLY IN MODERATION and IF YOU DRINK ALCOHOLIC BEVERAGES, DO SO IN MODERATION.

The Food and Nutrition Board of the National Academy of Sciences has recommended that daily intakes of salt (sodium chloride) be limited to 6 grams. This translates into a daily sodium intake of 2,400 milligrams. The average intake of sodium in 1989-91 was 3,074 mg--3,891 mg for men and 2,489 mg for women. These amounts are underestimated because they do not include salt added at the table. About 36 percent of individuals report "never" adding salt to food at the table, while 11 percent indicate that they use ordinary salt very often." Men are more likely than women to salt "very often."

Consumption of alcoholic beverages was 70 grams in 1989-91, up from 52 grams in 1977-78 (about a 35 percent increase). In 1989-91 about 11 percent of the population reported consuming alcoholic beverages, up from 9 percent in 1977-78.

About 80 percent of the alcoholic beverages consumed was for "beer and ale." In CSFII 1989-91, whites consumed more alcoholic beverages than blacks and high-income individuals more than low-income individuals.

I want to close by giving you just a brief picture of the results from the Diet and Health Knowledge Survey. This survey was designed to link with the CSFII so that we could look at how individual attitudes and knowledge about healthy eating affect food choices and dietary status. Results indicate that about seven out of 10 main meal planners/preparers were aware of health problems related to consumption of fat, six out of 10 were aware of health problems related to saturated fat, and eight out of 10 were aware of problems related to cholesterol. Yet the diets of most did not meet the saturated fat. Only one-fourth of both men and women met the recommendations for fat and saturated fat, while about half of the men and three-quarters of the women met the recommendation for cholesterol.

Main meal planners/preparers were asked if they thought their diets should be lower, higher, or were just about right in selected dietary components. Results indicate that people's perceptions do not always match reality. When asked to compare the levels of fat, saturated fat, and cholesterol in their own diet with "what is most healthful," both men and women meal planners tended to underestimate the amount of fat and saturated fat in their diets but overestimate the amount of cholesterol.

International Nutrient Database Activities

Joanne Holden, USDA-ARS

As a nation and as individuals we are participating in an increasingly global environment - trade, economics and banking, telecommunications, and of course, travel. Relative to food composition activities, we see increased global food imports and exports and the promise of continuing growth in the future due to the NAFTA and Uruguay GATT treaties. These trends are further supported by trade growth in other regions such as the continuing developments in the European Union, trade and economic activity in China and Africa.

As health professionals we may participate in the international arena in one of several ways. We may work for a food company that trades products and ingredients at the international level. Many of us develop or manage food composition databases which are used in international studies. Others collaborate with analysts, database managers, etc., in other countries to solve problems common to the generation of food composition data. Finally, many of us conduct surveys, clinical studies, or other assessments of populations including diverse ethnic groups.

The U.S. food supply relies on the availability of a variety of foods procured (obtained) from both U.S. and non-U.S. sources. Sourcing of food stuffs is determined by cost, climatic effects, agricultural and agronomic conditions (insect and disease) supply and demand, and trade agreements (conditions). For example, Table 1 shows the import and export statistics for soybeans between 1977 and 1991. The U.S. is one of the major exporters of soybeans in the world. Statistics for edible oils (olive, rapeseed, and palm kernel) indicate increasing imports of olive and rapeseed oils while imported supplies of palm kernel oil decreased moderately between 1987 and 1991 (Table 2). The U.S. exports significant amounts of orange juice concentrate. For example, 1991 approximately 85 million gallons of concentrate, representing more than one-half of the total U.S. production that year were exported (Table 3 and 4). At the same time, the U.S. may import orange juice concentrate at times during the same year as processed product or to meet manufacturers demands at a time when U.S. supplies are not available. Agricultural statistics for 1991 show large imports of beef and veal from Australia and New Zealand with lesser amounts coming from Canada and Costa Rica (Table 5). Finally data for apples indicate imports from Canada, Chile and New Zealand and exports to Canada, Taiwan, and United Kingdom (Table 6).

These statistics indicate the significant flow of food commodities into and out of the U.S. In addition, many processed single and multi-ingredient formulations enter the U.S. marketplace from other countries. The U.S. food industry exports major amounts of many processed foods as well. Similarly, other countries are involved in food trade as well. Up-to-date and accurate food trade data are needed to complete the tally of available food and to assess the effects of diet on health status. In particular, it is important to identify sources of the important contributors of components carried by foods in the food supply and to determine specific food composition data for those foods. Food component levels do vary as a result of several (many) factors including brand, cultivar, climate, maturity, distribution, etc.

Both developed and developing countries have documented the incidence of various types of cancers, cardiovascular disease, and diabetes in their countries and all are conditions which have been linked, in part, to dietary effects. In addition, specific micronutrient deficiencies (vitamin A, iron, iodine, etc.) and their effects are still prevalent to some degree in many regions of the world. Not only are we concerned by traditional nutrients, but we are beginning to look at the role of other (not new) dietary components--flavonoids, phenols, dietary carbohydrates, etc. Biological roles as pigments, catalysts, electron transport intermediates, etc. for many of these components have been known but new roles in human metabolism and health are being investigated. International epidemiological and clinical studies are conducted in collaborative arrangements by investigators in developed and developing countries in an attempt to elucidate the etiology of diet-health relationships. U.S. government scientific organizations conduct research and collaborate with other governments to study the etiology, prevention and treatment of various health problems. During 1992, the NIH conducted more than eighty studies in 19 countries concerning various cardiovascular and pulmonary diseases. The National Cancer Institute has collaborated extensively in studies concerning the development, treatment, and prevention of many cancers. As an example, the NCI supports the work of the International Agency on Cancer Research which has begun a prospective 10-year study, EPIC, enrolling 400,000 persons in seven countries to investigate the role of diet in the development of specific cancers. USAID supports international studies concerning high priority nutrients (vitamin A, iron, and iodine). Similarly, other countries are actively involved in global health research. Norway, France, and the Netherlands are collaborators in food and nutrition research taking place in Africa, Thailand, and Indonesia. The National Food Agency of Denmark is currently involved in projects in the Middle East. Universities and regional groups participate in international collaborations.

For many years peer reviewed articles in scientific journals have been retrieved globally. Increasingly, scientific meetings are international in nature. Representatives from many countries meet to share their experimental data and observations about topics of mutual interest such as analytical chemistry, standard reference materials, nutrient metabolism and database development and management. The relatively recent advent of electronic media, especially Internet and facsimile machines have increased global communication about biological and chemical sciences and related subjects. Food and nutritional sciences, including food composition research and applications have benefited from the global and regional communication process.

My objective is to present a summary of recent activities specifically related to food composition database development and to discuss the opportunities for involvement at the international, regional, national and even local level. Several international and regional meetings have been held to address worldwide demands for the development and improvement of food composition data and standardized procedures for accessing and exchanging data.

In October 1992, the International Conference on Nutrition was convened in Rome to develop a world declaration and plan of action for nutrition. Thirteen hundred delegates from 159 nations met to formulate the World Declaration and Plan of Action for Nutrition. According to the Forward of the Conference Proceedings "The World Declaration reflects the pledge of member countries, non-governmental organizations and the international community to eliminate or reduce substantially--within this decade--starvation, widespread under nutrition, and micronutrient malnutrition, which constrain progress in human and social development around the world." The Plan of Action for Nutrition provides a framework for achieving these objectives, ..." The World Declaration went on the cite Vitamin A, iron and iodine as important micronutrient deficiencies which need to be reduced or eliminated. Deficiencies of other micronutrients such as folate and other B-complex vitamins, vitamin C, selenium, Zinc, and calcium were discussed. Nine action-oriented themes were developed. Several focus on the provision of a safe and adequate food supply. One specifically addresses the need for assessment, analysis, and monitoring of global and regional nutrition situations. Included is the need for "the support and encouragement of the development and use of local food composition data. The International Conference on Nutrition bolstered the foundation for action on the improvement of food composition data at the global level. The availability of accurate and current food composition data are integral (essential) to the solution of worldwide nutrition problems.

In September 1993, the First International Food Data Base Conference was held in Sydney, Australia to provide a forum for the discussion of a wide range of topics related to the development, compilation and use of food composition data. The impetus for the meeting came from the accomplishments of the last 10-15 years in the area of food composition research and data use. Significant accomplishments have occurred in many regions of the world including the revision or initiation of comprehensive handbooks and databases of food composition, the development of improved analytical methods, the recognition of the role of reference materials, and the importance of statistical sampling and appropriate sample handling techniques. Speakers included representatives of the food industry, academia, national government organizations, and international organizations such as the Food and Agriculture Organization. The meeting was held as a satellite to the International Congress of Nutrition, which was conducted in Adelaide, Australia following the Food Database Conference. The Second International Food Data Base Conference will take place in Lahti, Finland, in August 1995 and will coincide with the commemoration of the retirement of Dr. Pekka Koivistoinen, a renowned leader in the field of food composition research.

In March 1994, the Discussion on Food Composition for Developing Countries was sponsored by the Food and Agriculture Organization and the United Nations University. Approximately thirty representatives of government and non-government organizations, including the food industry, academia, and national and international governmental bodies met in Tunis, Tunisia to assess the results of a decade of food composition activity under the auspices of various International, Regional, and National organizations and the International Network of Food Data Systems (INFOODS). A plan of work was developed to strengthen and stimulate international efforts in food composition by providing a network of investigators in developed and developing countries to work together to meet the challenges ahead. The report for the meeting provides the presentations of speakers concerning such topics as food description and nomenclature, data quality indicators, analytical methodology and quality control, training needs, sampling, data base inventories as well as presentations from FAO, UNU, food industry representatives, and representatives from China, Slovakia, Tunisia, Norway, Zimbabwe and others. A regional meeting for Africa will be held in Accra, Ghana in September, 1994 to define the specific needs of African Countries for food composition data and research.

Over 10 years ago the United Nations University (UNU) with the support of the U.S. National Cancer Institute, the Food and Drug Administration, and the U. S. Department of Agriculture conducted a meeting in Bellagio, Italy, of various international experts in food composition research. At that meeting, INFOODS was formed to identify needs and direct and coordinate global food composition efforts to increase the availability of accurate and representative data. During the last 10 years, significant accomplishments have been made to increase food composition data availability on a global level. The INFOODS Secretariat together with other collaborators have published books on various relevant topics and have promulgating standards for identifying components and foods. Regional centers for food composition have been established in Latin America and Oceania.

As an outcome of the recent Discussion in Tunisia, FAO will join with UNU to strengthen and expand global efforts in food composition data. Barbara Burlingame, Director of the New Zealand Institute of Crop and Food Research and Regional Director of Oceania Foods will serve as the Director of INFOODS. Dr. John Klensin is currently directing his attention to a new assignment with MCI telecommunications but will remain with the INFOODS office as a consultant when needed. In the near future, INFOODS will release a newsletter containing an update of recent activities. In addition, the INFOODs directory will be updated and distributed to interested colleagues.

In addition, the recently published book, Food Composition Data: Production, Management, and Use, by Drs. Heather Greenfield, University of New South Wales and David Southgate, formerly of the AFRC Institute of Food Research, Norwich, U.K. is a valuable handbook for those individuals working to provide accurate food composition data worldwide.

The improvement of food composition data is a complex and challenging task. A major barrier to the production and compilation of food composition data at national and international levels is the lack of knowledge and commitment on the part of those responsible for policy formulation and the allocation of resources. It is incumbent upon producers, managers and users of data to act as advocates within their professional networks to stimulate the necessary broad based support for the improvement of food composition data and the critical role these information play in health, research, agriculture, trade and food manufacturing.

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Soybean Trade, 1977-1991

Year	Imports (metric tons)	Exports (metric tons)
1977	105	16,195,496
1987	10,930	21,592,443
1991	121,476	17,530,932

Source: Agriculture Statistics, 1992, NASS

Oil Imports, 1977-1991

Year	Olive Oil	Rapeseed Oil	Palm Kernel Oil
	(metric tons)		
1977	24,633	6,876	69,896
1987	63,736	87,317	182,955
1991	98,709	307,127	145,715

Source: Agriculture Statistics, 1992, NASS

Concentrated Orange Juice: Annual Pack, 1977-1991

Year	(1,000 gallons)
1977	161,204
1987	169,973
1991	151,396

Source: Agriculture Statistics, 1992, NASS

Orange Juice:United States Exports by Kind 1977/78 - 1990/91

Year	Single Strength (1000 gals)	Concentrate	
		Hot Pack (1000 gals)	Frozen (1000 gals)
1977/78	8198	-	-
1987/88	7560	4,356	54,121
1990/91	0	11,624	85,074

Source: Agriculture Statistics, 1992, NASS

Beef and Veal: United States Imports, by Country of Origin, 1991

Country	Fresh, chilled and frozen	Canned, including sausage	Other prepared or preserved
Australia	349,831	18	0
New Zealand	211,871	266	0
Canada	80,660	306	476
Costa Rica	21,434	0	0
	.	.	.
	.	.	.
	.	.	.
Total	709,997	71,570	1,870

Apples, Fresh:United States Imports & Exports 1990/91

Country	Imports from: (metric tons)	Exports to: (metric tons)
Australia	157	-
Canada	58,382	74,885
Chile	24,720	-
New Zealand	21,704	-
Taiwan	-	60,839
United Kingdom	-	34,919

Source: Agriculture Statistics, 1992, NASS

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DATA BASE MAINTENANCE ISSUES

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Selection of Database Management Software

Brian Westrich, University of Minnesota

Abstract

For organizations involved in computerized data management, selection of database management software (DBMS) is an important decision with far-reaching implications. A method is presented for effective selection of a DBMS that meets organizational needs. The method involves determining the complexity of required data processing and the level of organizational resources, choosing an appropriate DBMS genre, developing DBMS selection criteria, and choosing a DBMS based on these criteria. A DBMS selection process recently completed at the University of Minnesota Nutrition Coordinating Center (NCC), which led to the selection of a DBMS consisting of PowerBuilder and DEC rdb, will be described to illustrate this method of DBMS selection. The intended audience is the computer literate scientist who has little or no experience in developing, integrating, or installing software.

Introduction

For the purposes of this paper, database management software (DBMS) is defined as software that automates the collection, storage, retrieval, and presentation of computerized data. For organizations involved in computerized data management, such as organizations working with food and nutrient data, selection of database management software is an important decision with far-reaching implications. In the remainder of this paper, a method will be described for selecting a DBMS that will meet the needs of an organization.

Methods

The recommended steps in the DBMS selection process include 1. choosing the DBMS tool genre based on required level of processing complexity and available organizational resources; and 2. formulating and using selection criteria to choose the best DBMS tool from this genre. Of these two steps, the first is by far the most important, and yet is often the one most neglected by those selecting DBMS tools. In the remainder of the paper, each of these steps will be described more fully.

Complexity of data processing tasks

The selection process begins with an assessment of the complexity of the overall data management goals of the organization. The simplest data management task is to merely store data for later use. As one moves to greater levels of complexity, one may wish to structure data, relate data, or perform complex high volume data processing (the levels of complexity listed here are not intended to be a complete list of all data processing tasks, but instead a list of the tasks most representative of a given level of complexity). In this section, each of these levels of complexity will be more completely described.

Storage

Data storage simply implies the ability to save data for later use. Storing data electronically offers several potential benefits over storing data in a paper file. A basic benefit to electronic storage is that calculations may be performed on these data without having to enter the data into a computer since the data is already in a computer. Another benefit is that electronically stored data are more readily searched than data stored only on paper.

Structuring

Data that is stored may also need to be structured. Figure 1 shows an example of structured data. In this figure, commercial product label information is broken up into different "pieces" (or fields), such as product name, ingredient listing, nutrient values, and other information. The advantage of such structuring is that one can more readily perform operations that are specific to a particular field. Examples of such field-specific operations include retrieval of all product names in the database, or retrieval of records for all products with a calorie content greater than a particular amount. In database terminology, the grid of data pictured in Figure 1 is referred to as a "table".

Figure 1: Example of structured data

Product Name	Ingredients	Serving size	Calories	Fat (grams)
Kellogg's Frosted Mini-Wheats	whole wheat, sugar, sorbitol, gelatin,	55 grams	190	1.0
Oak Grove Lime Sherbet	whey, water, sugar, corn sweeteners, ...	1/2 cup	120	1

Relating

Different types of structured data may need to have relationships defined between them. For example, product label information includes a list of one or more product ingredients. Rather than store all of the ingredient names in a single field, it may be desirable to create a new table which contains one row for each ingredient, as shown in Figure 2. Such a solution would allow, for example, the ability to store additional ingredient information, such as the estimated amounts of the ingredients.

If products and ingredients are stored in different tables, one needs the ability to define a relationship between these two tables. Such a relationship consists of the identification of one or more fields that are common to the two tables. For the example in Figure 2, the common field would be the product name.[1]

Figure 2: Example of two related data tables

(Product table)

Product Name	Serving size	Calories	Fat (grams)
Kellogg's Frosted Mini-Wheats	55 grams	190	1.0
Oak Grove Lime Sherbet	1/2 cup	120	1

(Ingredient table)

1 Arbitrary identification numbers are usually preferred over text descriptions in such situations because of computing efficiency and data integrity purposes. Specifically, numbers can be processed by computers much faster than text, and also take up less space, and if the text names are modified the relationship between the two tables may be compromised.

Product Name	Number	Name	Estimated amount (grams)
Kellogg's Frosted Mini-Wheats	1	whole wheat	23
Kellogg's Frosted Mini-Wheats	2	sugar	12
Kellogg's Frosted Mini-Wheats	3	sorbitol	8
Kellogg's Frosted Mini-Wheats	4	gelatin	4
Kellogg's Frosted Mini-Wheats			
Oak Grove Lime Sherbet	1	whey	50
Oak Grove Lime Sherbet	2	water	30
Oak Grove Lime Sherbet	3	sugar	15
Oak Grove Lime Sherbet	4	corn sweeteners	12
Oak Grove Lime Sherbet	...	...	...

Complex high volume data processing

There may also be a need to perform extremely complex processing tasks, as well as process high volumes of data. An example of complex processing tasks is the management of time-related databases. Time-related databases distinguish between changes due to changes in the food marketplace and changes due to better nutrient data, and thus allow nutrient calculations to be comparable over time. Management of time-related databases requires the use of highly sophisticated database management techniques.

High volume processing usually also requires the ability for multiple users to simultaneously enter, browse, and update data; the ability to automatically keep a record of all data transactions made for data integrity and auditing purposes; the ability to ensure that user errors or hardware failures do not lead to corrupt data; the ability to perform data backups at the same time that databases are being modified; and the ability to readily upgrade to more powerful hardware such as UNIX workstations and multiprocessor machines as processing needs increase (scalability).

DBMS genres

There are several genres (or families) of DBMS tools that correspond to each of the levels of processing complexity that were previously discussed. These include word processors, spreadsheets, personal DBMS tools, industrial DBMS tools, and third generation DBMS tools. Word processor tools are the best choice when one wishes to merely store data in an electronic format. For such tools, no preparation in terms of data structuring or software development is needed before data entry can occur, and data entered can be readily searched.

At the next level of complexity, where one also wishes to structure one's data, an electronic spreadsheet is the tool of choice. Spreadsheets present the user with a grid within which data can be entered, and thus allow the data to be structured with minimal effort. The ability of spreadsheets in data management is often underestimated. Almost from the beginning, spreadsheets were designed with the intent that they would be data management tools. The "Lotus 123" software package was so named because it was designed to accomplish three functions, one of which was database management. Spreadsheets continue to be unparalleled in their flexibility at setting up ad-hoc data management applications, which makes them ideal tools for prototyping more complex applications. Recent additions such as the Data Forms feature of Microsoft Excel (which allows "instant" creation of data entry screens) continue to add to the power of spreadsheets as data management tools. In short, one should not underestimate the ability of spreadsheets to perform data management tasks.

Personal DBMS tools allow one to relate data, and thus are more capable than spreadsheets for handling tasks that involve multiple types of structured data. Using personal DBMS tools, multiple data tables can be created and related to each other. Data entry forms and data queries that exploit these relations can also be readily created. Examples of personal DBMS tools include XBase packages such as DBase III, FoxPro, and Clipper, as well as other packages such as R:Base, Paradox, and Microsoft Access.

Industrial DBMS tools provide all the features of the previous genres, but also provide the types of features historically found on mainframe computers which allow complex high volume data processing. Such features include the ability to log all database transactions for historical purposes, the ability of multiple users to simultaneously access and update databases, and the ability to perform more complex data processing than do personal DBMS tools. One example of such processing is an SQL sub-select query. SQL sub-select queries greatly aid in the management of time-related databases, but are not currently supported by most personal DBMS tools.

One trend in industrial DBMS tools is to employ a computing architecture referred to as "Client/Server". In a Client/Server architecture, processing tasks are divided between a computer called a "server" which runs software that receives requests for data and provides data, and one or more computers called "clients", which run software that handles screen displays, and requests data from the server. Only those tasks needing central management (data storage, data integrity) must be performed by the server. Other tasks (user interface, data presentation) can be delegated (or "offloaded") to the clients. This division of processing labor allows the processing of large volumes of data using more cost-effective hardware (microcomputers and workstations versus minicomputers and mainframes). It is common to use the term "Client/Server DBMS" to refer to industrial DBMS's, but this terminology is not used in the current paper since the distinguishing characteristic of an industrial DBMS is not its Client/Server architecture but its ability to perform complex high volume data processing. Another reason why the term industrial DBMS is preferable over Client/Server DBMS is that when one uses a Client/Server architecture, one can use different genres of DBMS tools on the client side. For example, one could access one's data on an industrial database server not only through an industrial DBMS client software, but also through a word processor, spreadsheet, or personal DBMS[2].

The last genre of database tools to be discussed are DBMS tools based on relatively "low level" computer languages such as C or Pascal. Low level computer languages are harder to understand and are also less concise than are the languages used in other DBMS tool genres. Because of this, DBMS tools based on low level languages require highly skilled staff and are also much more labor intensive to use. To help counter this, third party libraries can be used to manage database management functions such as storage and retrieval of data. However, such tools do not usually provide users with the same level of facilities as do industrial and personal DBMS tools. For example, users of low level languages and third party libraries must still write custom programs to display data, as well as to do such database maintenance functions as creating, displaying, updating, and deleting database structures and the contents of these databases.

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2 In some situations, the term DBMS is used to refer to the database server software (as opposed to the database client software), though such usage is not adopted in the current paper.

Though DBMS tools based on low level languages are more labor intensive and require more highly skilled staff than do other DBMS tools, they are inherently more flexible than other DBMS tool genres (in fact, most other DBMS tools are written using these low level languages). Thus the use of low level languages may be justifiable in certain specific circumstances. For example, some dietary data collection and processing software packages have specific requirements with regard to system performance and hardware platforms that only a low level language may be able to satisfy. Software developed by the University of Minnesota Nutrition Coordinating Center for the NHANES III study was designed to conduct a dietary interview using a hierarchical, time-related food database with suitable response times to allow one to conduct dietary interviews using 80286 based microcomputers. At the time that this software was implemented, such processing was only possible using a low level computer language; thus this software was implemented using the C programming language as well as a third party DBMS library. As hardware performance and capabilities of fourth generation languages continue to increase, for the most demanding applications there will be a continued and inevitable movement away from low level language DBMS tools and towards other tools that provide sufficient flexibility at greatly reduced development cost.

Genre selection

Table 1 shows, for each level of processing complexity previously discussed, the level of organizational resources (personnel and hardware) and the DBMS tool genre that is needed to support this level of complexity. It is worth emphasizing that one's organizational resources must be sufficient to support the level of complexity of data processing that one plans to perform. For example, if one needs to relate data, one needs a part-time data manager or consultant to manage the DBMS tools as well as to provide overall guidance in developing databases and database applications. A common error is to attempt to use a database genre that requires more resources than are available. This error leads to inefficiency due to lack of knowledge of, or technical support for, the database tools. Such a situation can negatively impact on the organization and lead to an eventual mistrust of the DBMS tools that were initially chosen, rather than a recognition of the true source of this difficulty, which is a mismatch between organizational resources and the DBMS tool. Thus, it is important to verify adequate organizational resources before committing to the performance of a particular level of data management complexity. Therefore, to select the appropriate tool genre for an organization, one should first establish the desired level of task complexity and also verify that the required organizational resources are available.

Table 1: Appropriate processing complexity and organizational resources for a given tool genre

Complexity	Minimum required resources	Genre
Storing	Paper	Non-automated
Electronic storing	Computer.	Word processor
Structuring	Semi-skilled staff.	Spreadsheet
Relating	Part-time computer staff	Personal DBMS
Complex, high volumn	Full-time computer staff; network	Industrial DBMS
Highly specific	Highly skilled programmers. Network of high performance workstations.	Low level language

The genres in Table 1 are guidelines as opposed to absolute rules. For example, many word processors have the ability to structure data through use of data tables, not all personal DBMS tools allow one to relate data, and it is sometimes difficult to draw the line between personal and industrial DBMS software. But despite such exceptions, these genres are useful categories for illustrating the major differences between available DBMS tools and for aiding in the selection of DBMS software.

Selection criteria

The next step after choosing the DBMS genre is to develop a list of selection criteria that are specific to one's organization. Everest (1991) has developed a generic list of database features for this purpose.

Available tools in genre

Once the tool genre has been decided, one can immediately focus one's tool search to those tools in the specific genre. Because of the large number of available DBMS tools, such focus can make the DBMS selection process much more manageable. While assembling this list of tools, one often learns of additional DBMS features that were omitted from the initial selection criteria. This information can be used to further update the selection criteria as needed.

Tool selection

The final step, DBMS tool selection, uses the selection criteria to select the DBMS tool of choice. Quantitative methods may be used to accomplish this selection. Such methods assign weights to each of the selection criteria, score each package in relation to each criteria, and use these scores and weights to calculate an overall score for each product. The product with the highest score is then chosen. However, because of the large amount of time and effort needed to thoroughly evaluate a DBMS tool (during which the DBMS tool market may change!), and because the genre selection process has already ensured that any tool chosen will match the desired level of processing complexity and the amount of available organizational resources, it may be more realistic to find a tool that does what one needs to do, rather than to find the "best" tool. Thus, a less rigorous approach may be preferable to the quantitative approach.

Hands-on evaluation of DBMS tools is often helpful in the final stages of DBMS tool selection. Such evaluation can be facilitated by vendors who are willing to supply evaluation copies of DBMS tools.

Example application of method

In the Summer of 1993, the University of Minnesota Nutrition Coordinating Center (NCC) selected a set of DBMS tools to meet its current and future organizational needs. The mission of NCC is to develop state of the art tools for diet assessment. Since effective management of large and complex databases is the central aspect of this activity, complex high volume data processing is a necessity. NCC has a full time programming staff, a dedicated network administrator, and the complete cooperation of the manager of the computing resources of NCC's parent organization, which includes a minicomputer running industrial DBMS server software. Thus, the industrial DBMS genre was the genre of choice for NCC.

The NCC client software selection criteria included (in order of importance) flexibility, multi-developer support, productivity, performance, training, import / export of data, ad hoc data manipulation, portability, vendor experience and viability, connectivity, documentation, end user tools, and price. The server software selection criteria included (in order of importance) functionality (for example, ability to manage time-related databases), connectivity (ability to use a variety of types of client software), data integrity (recovery from hardware failures), performance (speed), scalability, documentation, training, and price. Note that for both client and server, software price was the least important criterion. This reflects the fact that software costs are a small fraction of the costs of hardware and development personnel, and these two latter costs were already taken into consideration during selection of the database genre.

NCC selected DEC rdb for database server software, and PowerSoft's PowerBuilder for database client software. However, other organizations using the DBMS selection method described here will likely select different tools due to differing organizational needs and environment. PowerBuilder was selected primarily because of its ability to produce database applications that utilize a graphical user interface, because of its ability to use object oriented development techniques to improve developer productivity, and because of its ability to work with a wide variety of database servers. DEC rdb was selected because of its ability to work with PowerBuilder, as well as its availability (including maintenance and support from full-time systems personnel) on a minicomputer of NCC's parent organization, and the ease with which PowerBuilder applications can be ported to another database server in the unlikely event that sufficient computer processing power cannot be allocated to NCC from the organizational minicomputer. Another possible benefit of the PowerBuilder rdb combination is that the mechanism used for communication between client and server is the Open Database Connectivity standard (ODBC), a standard also used by the EuroNIMS Food Information Management System (EuroNIMS, 1994).

NCC plans to migrate all of its databases and database applications to the PowerBuilder / rdb environment. In doing so, the advantages of increased data integration will be realized, as well as increased long-term application development productivity through the use of the object-oriented application development capabilities of PowerBuilder.

A key advantage of following a methodological and well-documented selection process is that decisions emerging from such a process are readily defensible in the future, and can be revisited as technology progresses, as organizational needs evolve, and as available resources change. For example, a DBMS tool that is a competitor to PowerBuilder (ObjectView) recently issued marketing materials claiming their product to be far superior to PowerBuilder. In checking the documentation for NCC's DBMS selection process, it was found that when NCC selected PowerBuilder (in the Summer of 1993), the available version of ObjectView (2.0) had been reviewed in several articles and found to be less mature than PowerBuilder (Rayl, 1992; Anon, 1992; Anon, 1993). This suggests that the choice of PowerBuilder was a reasonable one at the time. Furthermore, it is also possible that the next version of PowerBuilder may again surpass ObjectView, resulting in a "leapfrogging" of the two products. Due to the learning curve of industrial DBMS tools, it is clearly inappropriate to switch to a different tool every few months. Therefore, the decision to choose PowerBuilder, and to stay with it in the near term future, can be readily justified.

Summary

Effective DBMS selection is critical to organizational success. The most important step in DBMS selection is identification of the DBMS tool genre that best matches one's required processing complexity and available organizational resources. Genre selection quickly eliminates many DBMS tools from consideration, thus making the DBMS selection process more manageable. After the appropriate genre has been selected, one should formulate selection criteria that are specific to one's organizational needs, identify tools in the DBMS genre, and use the selection criteria to select an appropriate DBMS tool.

Conclusion

As computer technology continues to rapidly progress, those confronted with decisions can facilitate the decision making process, as well as justify their decisions in hindsight, through using a clearly planned, documented selection process. Successful DBMS selection and use, and ultimately the success of the organization, is facilitated by the use of such a process.

Final note

Despite the focus here on the importance of selecting the best tool for a particular situation, one needs to keep in mind that most organizations have multiple data management needs. Just as an effective carpenter keeps more than one tool in her toolbox, an effective data manager usually needs more than one tool in her database management toolbox. Thus, all but the tiniest of organizations will benefit from using tools from more than one of the DBMS tool genres of word processor, spreadsheet, personal DBMS, industrial DBMS, and low level language DBMS tools.

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Software Testing

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Knowledge about software testing is critical not only for software designers, programmers, and professional testers, but also for buyers and users. Most of us fall into at least the last category!

Why should software be tested?

The goals of software testing, no matter who is doing the testing or where it is done, are to achieve confidence in the software and to reduce risk of errors caused by program "bugs." A bug is programming code that results in program function or output that is other than required program function or output. Bugs can be relatively innocuous (a typographical error on a screen), annoying (after a certain combination of keystrokes the program bombs), or very serious (the calculation procedure for averaging nutrient data is faulty).

Testing and debugging are not at all the same. Testing and test design focus on bug prevention and on uncovering bugs. Debugging may be the logical consequence of testing. The purpose of debugging is to find the code that led to program failure and to change the code accordingly.

There are ways that programmers can prevent or reduce program bugs. The source language can be very important. Programmers can adhere to certain stylistic criteria and/or design methodologies. Static analysis can be done. Software inspections can be performed. However, testing is needed even if these other features are incorporated.

Software testing can show some, but not all, defects in program code. Testing can demonstrate that the program function is correct or incorrect and can demonstrate that the performance is correct or incorrect. Testing can detect logic failure; this means that the program is doing what it was told to do, but that someone's reasoning (the developer or programmer) was faulty in some way.

Who should be part of the software testing process?

The buyer and/or user of software must play a major role in the software testing process. In contracted software development, personnel from the contracting institution should work with the developer during the planning and design process so that all parties agree on what the final system will consist of and how the system will look. Joel Gilman, in a Law Report column in the February 1991 *Systems Integration* (1) suggests that a test-criteria document should be drawn up if possible and included in the original system proposal or contract.

Buyers should consider software testing key features even for off-the-shelf software products. Bill Hancock, in a column titled "Confessions of a testing fanatic" in the November 12, 1992 *Digital News and Review* (2), related a horror story about an off-the-shelf word processor program crashing, with work lost prior to an important deadline. We've all come close to this at one time or another.

Programmers should be responsible for basic software testing. A programmer should never hand over a program to a tester or testing department without first processing enough test cases to determine whether the program is meeting specified requirements.

It should be noted, however, that testers and programmers have different goals when they are testing software. Boris Beizer, in *Software Testing Techniques* (3), an excellent basic book on testing, said that a tester is "one who writes and/or executes tests of software with the intention of demonstrating that the program does not work." He said that a programmer is "one whose tests (if any) are intended to show that the program does work."

What is software testing?

Software testing is a process, the purpose of which is to prevent and uncover "bugs" in the software and to determine whether systems meet specified requirements. It is by nature poorly defined, always incomplete, costly, and time-consuming. It has been estimated that testing consumes more than half the labor expended to produce a working program (3).

There are four general categories, often referred to as "stages," of software testing.

<u>Unit testing</u> is testing of the smallest testable piece of software (a single component of the system). The purposes of unit testing are to assess whether the unit satisfies its functional specification and/or whether its structure matches the intended design structure. Unit testing should be done by the programmer. There are a variety of tools a programmer can use to assess whether all paths the software can take have been tested.

In integration testing, the goal is to test what happens when units are combined. Usually if a problem is found, it has to do with information passed between units.

System testing, as the name implies, is aimed at testing the entire system. It tries to find problems other than those that can be attributed to units or interactions between units. In system testing, one might look at performance, security issues, and other issues of these types.

Acceptance testing is a broad category that provides final certification that the system is ready for real-world use. It may involve very intensive tests that look at the positive and negative aspects of the system. Functionality is closely examined. For contracted or in-house software, errors found at the acceptance testing stage usually involve some type of misunderstanding on the part of the developer or miscommunication between buyer and developer.

There are other terms for testing which may be done during the course of one or more of the testing stages. These include testing for reliability and usability, conformance to standards, interoperability, and regression testing.

Reliability testing assesses acceptability considering intents, actions, and decision processes of users. Measurement variables may include learning time, task performance time, error rates, error recovery time, and end-user satisfaction.

Conformance testing checks conformance to standards. Organizations issuing standards related to software include (but aren't limited to) the International Standards Organization, British Standards Institution, American National Standards Institute, and the Institute of Electrical and Electronics Engineers. However, there are other kinds of standards software can meet. For example, MS-DOS itself is a kind of a standard.

Interoperability testing assesses whether a system can work effectively with other systems meeting the same standards.

Regression testing involves tests created for a previous version of the software. When the system has undergone a change, testers usually repeat some or all of the tests performed on the last version of the software just to make sure that the change didn't adversely affect an unrelated function.

When should the testing process begin?

Testing, of course, can't begin until some code is written. However, the testing process should begin when the software development process begins. Time spent eliminating bugs is much shorter when testing is planned during the design phase than at the end.

System requirements should be written down and agreed upon by all parties, and these requirements specifications should be used as the basis of a testing plan. Software design objectives should include testability.

When should the developer stop testing and deliver the product? The decision may be based on metrics (measurements of error rates). However, the key decision will always be based on the resources available. If testing staff have nothing else to do, and lots of time until the software is needed, one might be able to be very cautious and extend testing at each stage for a long time. However, if the software was promised 6 months ago, and especially if a competitor is moving in, the developer might be willing to take the risk that the program works without serious bugs, even if he or she knows about some minor bugs.

It all boils down to risk assessment and being able to project the point when it is more-or-less safe to send out the product. If a faulty product is sent out, a new version can be released; however, this involves a whole new set of risk assessments.

The cost of sending out a new version must of course be considered. But a developer also has to consider the image of the company—sending out a new version can make a developer look responsive, innovative, or incompetent, depending on the timing and on the extent of change.

Where should software be tested?

This depends a lot on what kind of testing is planned. Presumably, the programmer will do some testing at his or her desk. If the company has testing facilities, or contracts out some of the testing, then testing will take place in these facilities. Sometimes a "pilot company" is created to simulate user conditions. And finally, some of the final acceptance testing should be performed at the buyer/user's facilities.

How should a testing plan be written and executed?

Testing plans at each stage should be based on structured requirements. These requirements should be written down and agreed upon by all parties before code is written. Structured requirements include any relevant definitions and input, process, and output requirements. In test planning, the steps are to finalize these requirements specifications, design the tests, map the tests to the requirements, and finally, designate the test cases and/or acquire a test set.

Test case design is its own science. The goals are to identify all of the types of cases that might occur under each scenario. After the code to be tested is written, the tester executes the planned tests, evaluates the results, and provides feedback. This feedback becomes a matter of record for the system. People who get the feedback would vary depending on the testing stage.

Examples of software tests

Example 1. Sample tests for food consumption analysis software

The TAS International Diet Research System® (TAS-DIET) uses U.S. Nationwide Food Consumption Survey (NFCS) and Continuing Survey of Food Intakes by Individuals (CSFII) data to report on food intake by the U.S. population and population subgroups. One of the definitions basic to the system is that the "3-day population" consists of respondents (for the survey in question) for whom three full days of survey data are available, regardless of whether food was actually consumed on any or all days. This definition applies to the total survey population, but can be extended to each survey subpopulation defined by the system; for example, the 3-day population of Hispanics consists of Hispanic respondents for whom three full days of survey data are available, regardless of whether food was actually consumed on any or all days.

In order to test whether the 3-day population definitions actually used by the system meet the definitions set out in the system requirements, analyses of 3-day average food consumption by the total population and each defined subpopulation should be performed and the results evaluated to determine N's reported by the system.

Running the analyses with the total population and each defined subpopulation might seem like an excessive number of test cases to test the definition of "3-day population" used by the system, but it really is possible that the system could be using the correct definition when using data for the total population but be totally off for one or more population subgroups.

To evaluate the results of these tests, the N's appearing on reports generated by the system should be checked against USDA documentation for N's in the total population and applicable subgroups. Because the documentation doesn't necessarily include N's for all of the population subgroups defined by the TAS system, the N's for the subgroups should be added together to check that the sums equal the N for the total population.

Example 2. Sample tests for food composition analysis software

A fictitious system, NUTRI-NOW, accepts an NDB number as input, retrieves appropriate nutrient data, and prints the nutrient data to the screen. The system must accept valid NDB numbers but not invalid numbers. There is only one processing requirement—to retrieve the most current USDA published nutrient data for the input NDB number.

For output, the system must display an error message if the input NDB number is invalid; for valid NDB numbers, the nutrient data must be shown in the appropriate order (which ordinarily would be included in the requirement specification) and in the appropriate units (which ordinarily would be specified for each nutrient).

In testing to see whether the system accepts valid NDB numbers, at least the lowest valid number and the highest valid number should be tested. If there are invalid numbers in the middle somewhere, the numbers before and after each of these numbers should be tested.

In testing to see whether the system rejects invalid NDB numbers, a wide variety of test cases should be processed. These test cases should include, at a minimum, the number lower than the lowest valid number; the number higher than the highest valid number; a number with spaces in the middle; a number with alpha characters in the middle; a "number" with alpha characters at the beginning; a number with special characters in it; and all zeros.

Summary

Testing should be more than a software life-cycle phase, and testing is not debugging. Testing should be carefully considered when designing software or planning software purchases. Software users should consider themselves software testers.

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A New Recipe Calculation Model

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Since the early 1960's, methods for calculation of nutrients in recipes have appeared in the literature. Neither foodservice facilities nor dietary surveys are likely to have the resources to analyze the nutrient composition of recipes in a chemical laboratory. Thus, estimation of nutrients with a computerized database system is the most common method for determining nutrient profiles for recipes. However, after using computers for over 30 years to estimate nutrients for recipes, a unified methodology has not evolved.

Current Methods

Although modeled for different purposes, the Retention Factor Method and the Yield Factor Method are the two most frequently used methods. Merrill, et. al (1) published a monograph describing the calculation method used to estimate nutrient values for home-prepared foods in Agriculture Handbook No. 8. This method, commonly referred to as the Retention Factor Method, has been described by Perloff (2-3). In this method, ingredient weights are adjusted with overall moisture and fat change factors and nutrient values are adjusted with nutrient retention factors (4-6).

With the availability of computer technology to support foodservice operations another model was designed for recipe calculation (7-10). This method commonly referred to as the Yield Factor Method relies on in-house and published food yields (11) to adjust ingredient weights to reflect food preparation, cooking effects, and removal of refuse. The nutrient profile for each ingredient corresponds to the finished form of an ingredient in a mixed dish. Recipe databases are a part of the infrastructure in a foodservice system and support menu management functions.

These two methods have different data requirements. Recipes coded with one method cannot be converted for use with the other method without considerable data modification.

Rationale for a New Recipe Calculation Model

A new recipe calculation model is being proposed to provide a versatile, integrated model that will facilitate data portability. Several authors (12-14) have addressed recipe calculation methodologies; however, a new model drawing on the advantageous features of the existing models has not been proposed. For some time, I have been encouraging development of a single comprehensive recipe calculation model that could be utilized for foodservice operations, product development, metabolic research centers, dietary surveys, or patient care.

Data portability would be enhanced if an integrated model were adopted. Recipes coded in one system could be loaded into another system without investing a large amount of coding effort to tailor recipe data.

Options for Implementing a New Model

A new model could be implemented by either re-engineering existing methods or designing a new integrated model. Re-engineering will probably be an appealing option to those who have existing systems; it preserves the investment already made in systems development. Thus, I will address the enhancements needed in the common methods to achieve a more versatile method.

Design of a new integrated model offers an opportunity to make improvements in how data structures are defined and to eliminate data redundancy throughout a recipe data base. In this paper, I will attempt to incorporate all of the unique features of existing models into a new integrated model and will propose some supporting data collections.

Enhancing Existing Methods

Enhancement of the Retention Factor Method for use in organizations where food production support is needed will require several new features. Although this method was never intended to facilitate food production, some individuals responsible for foodservice are interested in using the features of the Retention Factor Method for nutrient calculation. To support food production, the Retention Factor Method should:

- Preserve "As stated" ingredient weight including any refuse that might be present.
- Document ingredient weight adjustments by recording the factors used to arrive at an edible portion weight.
- Link ingredients to food inventory by recording the ID of the purchased form of the ingredient.
- Provide for inedible parts in served weight of a portion such as bones in BBQ ribs or chicken drumsticks.
- Include weights for fat when an ingredient so that the proper amount will be purchased and costed.
- Maintain standardization data indicating the yield and portions/batch for comparison with calculated values.

Several features are needed in the Nutrient Retention Factor method to support food production. The Nutrient Retention Factor method should:

- Identify re-usable by-products such as fats used for deep-fat frying or meat scraps that can be used in another recipe.
- Include EP-->AP factor to assure that an appropriate amount is purchased when an ingredient weight is stated in an EP form of the food (e.g. onions, peeled).
- Accommodate handling losses that occur normally during food preparation process (e.g. sauces that adhere to the cooking container).
- Document batch sizes (Min & Max) to provide information for recipe forecasting and scheduling.
- Include advance preparation code to indicate recipes or ingredients within a recipe which require some advance preparation.
- Include cost/price data to identify portion costs for the support of food cost accounting modules or for menu pre-costing.

Several enhancements are needed in the Yield Factor Method to convert it to an Integrated Recipe Model. All of these enhancements are related to the calculation of nutrient values because the Yield Factor Method was originally designed to support food production and service. Specifically, the Yield Factor Method could be enhanced to:

- Link to nutrient retention factors to adjust for vitamin and mineral losses in ingredients.
- Adjust nutrient retention per ingredient using the retention factors rather than using the nutrient profile for only the finished form of an ingredient.
- Preserve moisture/fat change factors that relate to overall changes in a recipe.
- Preserve NDB ID of the specific fat that is associated with the fat change factor (e.g. bacon fat lost from frying bacon).

- Adjust for overall moisture change by adding new computational logic to adjust the aggregate moisture value for a recipe.
- Adjust for overall fat change by adding new computational logic to adjust the aggregate fat and fatty acid values using the fat change factor and the nutrient profile for the specified fat.

With the enhancements noted, both the Yield Factor and Nutrient Retention Factor methods could be made more versatile and compatible.

Design of a New Integrated Recipe Model

For organizations without an investment in existing software modeled on either of the common models, a new strategy could be implemented using the factors and advantages of the existing methods. A new strategy could be implemented to expedite data coding and, in the long-term, reduce the data maintenance effort.

As some of you will remember from last year, I suggested that, from a structural standpoint, nutrient databases will probably have a complex configuration. With enhancements in computer technology, we have begun to separate data according to type of data such as nutrient values or food descriptions and to provide links to data rather than coding redundant values in a data base. In this proposal for a new Integrated Recipe Model, a relational data base model influenced how some of the recipe data are segregated.

Criteria for a New Recipe Calculation Model

This integrated model was planned to meet the following criteria:

- Provides coding flexibility allowing use of either the Nutrient Retention Factor or Yield Factor methods.
- Documents weight adjustments due to advance preparation or refuse losses.
- Provides data coding diagnostics to alert a coder to inconsistencies between food production data and calculated yields and portion weights.
- Provides links to supporting data rather than coding redundant data within the Recipe Data Base.
- Minimizes the data maintenance effort by eliminating redundant data that might be coded inconsistently across recipes.
- Integrates with system modules to provide support for diet planning, food procurement and production, and financial management.

Components of an Integrated Recipe Model

The primary components of an Integrated Recipe Model are: Recipe General Information, Recipe Ingredient Information, Recipe Nutrients, Recipe Preparation Procedures, and an Ingredient File with alternative "as stated" forms and associated yield factors. The contents of each of the data collections are itemized on Handouts 1 and 2 . Although I attempted to be comprehensive with respect to data fields, I did not address the size or specific options for each data field.

The Recipe General Information is that information which refers to the total recipe and includes recipe identification, overall change factors, recipe standardization data, calculated recipe data, and diagnostic information.

On the first page of Handout 1, some of the fields of recipe general data are itemized. This list is not offered as a data structure. Instead, this list is proposed as an extensive listing of data that might be preserved about a recipe. The calculated and diagnostic data indicated near the end of the left column could be recalculated each time a recipe is modified rather than stored in a data structure. Some data fields have the term "multiple records" beside or under them indicating that more than one option could be preserved. The handling losses could be coded to account for post-production losses such as handling losses, carving losses, etc. These losses influence the batch yield in terms of both total weight and number of portions.

For foodservice operations, intermediate and finished recipe and portion weights are useful. A coding system for Recipe Standardization Status can be employed to indicate if a recipe was coded without recipe testing, after thorough recipe testing, or somewhere along that continuum. The Yield/Batch Size provides a reference point for comparing calculated values for a recipe. Similarly, the Portion Sizes indicate the expected size of different types of portions when a recipe is coded and prepared. On Handout 1, data fields related to recipe standardization are itemized in the middle of the left column.

The right column on the first page of Handout 1 is recipe general information for food service with the exception of the first field which is a flag to indicate if nutrients for the recipe are to be calculated with the yield factor method. The remainder of the data fields on the right column is grouped into categories of information such as production information, serving information and cost/price information. Most of those data fields could be left uncoded if recipe nutrients were the only desired output in a specific setting.

In the Integrated Recipe Model, the amount of information that would be maintained in the Recipe Ingredient Information would be limited to the quantity of the ingredient, links to the appropriate entries in an Ingredient File, some ingredient flags, and a link to recipe preparation procedures. Activation of the Ingredient Type flag identifies when an ingredient is another recipe such as a white sauce or is a re-usable by-product such a fat left over after deep-fat frying. A recipe ingredient flag could be activated to prevent an ingredient from being included when weight adjustments are made for moisture losses or gains (e.g. garnishes which are served with a finished dish but are not cooked). This simplified data record for each ingredient would prevent data redundancy such as ingredient names and yield factors and would minimize the data maintenance effort. Similarly, recipe coding should be faster and require less individual judgement.

Two other recipe files are those for the calculated Recipe Nutrients and for the Recipe Preparation Procedures. Both of these files can be stored with very simple data structures. The data fields proposed for each are itemized on the back side of Handout 1 in the right column. Provision is made for nutrient values for only 100 grams of each recipe to minimize the number of values that must be maintained for each food. A computer can assume the role of calculating the quantity of each nutrient in an amount consumed by a respondent or for designated portion sizes. The text of preparation instructions for a cook would be maintained in the Recipe Preparation Procedures file. The ID of the preparation step serves as the link to the recipe ingredient information in the opposite column of Handout 1.

An Ingredient File is proposed as a centralized collection of information that might be required for nutrient calculation and for food procurement and production. A list of the data fields in an Ingredient File is shown on the first page of Handout 2. The detail coded about alternative forms of ingredients could be maintained in this file rather than in the ingredient records in a Recipe Data Base. With this configuration, the details about each ingredient would not have to be coded each time an ingredient appears in a recipe.

In recipes, the same ingredient may be "stated" on different recipes in terms of alternative forms. For example, raw onions might be stated on one recipe as "onions, chopped" and on another as "onions, quartered". Including alternative forms of a food in the Ingredient File would be a way of preserving the name of ingredients stated on a recipe. Sometimes, ingredient names include preparation information such are peeling, slicing, draining, etc. The weights of different measures of each alternative form could be preserved in the Ingredient File or as a separate related data collection.

By preserving information about alternative forms of ingredients, EP-->AP factors could be derived and coded for each alternative form. EP-->AP factors are especially important in a database system supporting food production activities. Foods may be purchased in bulk in an unprocessed form but stated according to some processed amount in a recipe. In those instances, a EP-->AP factor is necessary in the data base system to convert the amount stated in the recipe to the amount that must be purchased. This factor is not involved in computing a nutrient profile for the recipe but is required to correctly cost the ingredient in the recipe when some pre-preparation occurs in a foodservice facility.

Several preparation options may exist for each alternative "As Stated" form. Appropriate yield factors and nutrient retention factors could be associated with each option. If the Ingredient File were the depository for yield factors, the actual values could be coded for each preparation option; otherwise, the IDs of the appropriate yield factors could be referenced in another data collection.

Frequently foods are served with non-edible parts (eg. bone in a pork chop); the non-edible portion needs to be included in the portion weight in order to monitor recipe yield and portion control. However, the nutrient values for the portion should correspond to only the edible portion. Thus, a link to a refuse factor would be necessary to eliminate the weight of refuse in a served portion.

Two fields have been allowed for Nutrient Data Base ID. If the Nutrient Retention Factor method activated, the ID for the "As Stated" form would be utilized. The ID for the "Served" form would not be required unless the Yield Factor Method were activated. Of course, in some instances, both data fields might reference the same entry in a Nutrient Data Base.

Several flags are included in the Ingredient File to record information about ingredients. One flag is available in this file to indicate if an ingredient is available as a government commodity item. Other flags are available to code advance freezer withdrawal and advance preparation.

Data in the Ingredient File could be stored in a Food Inventory File. However, I would like to offer a justification for a separate file. First, an Ingredient-->Food Inventory Cross Reference could be constructed very easily as shown at the bottom of Handout 2, and the Food Inventory ID could be displayed on recipes and all food purchasing and inventory documents. Secondly, organizations sometimes change food vendors and would be more independent if vendor catalog numbers were not embedded throughout in-house data collections such as recipes.

Thirdly, an Ingredient File might be developed as a generic data collection that could be integrated into different software systems. In this way, a lot of redundant effort might be eliminated. I believe that data coding consistency would be improved in recipes, also.

Could we begin to think of an Ingredient File in much the same way we think of a Nutrient Data Base? Would we be able to identify what Alternative Forms and Preparation Options should be included? No doubt, the contents would be expanded over time and not every organization would require all of the alternative forms or preparation options.

Related Data Collections

Some other related data collections are: Units of Measure, Portion Sizes, a Nutrient Data Base, Nutrient Retention Factors, and Refuse Factors. Yield Factors and Weights of Measures could also be preserved as separate data collections. With data in the related files linked by relational keys, data redundancy can be minimized. Coordination of these collections of data will reduce reliance on printed documentation and will support on-line, real-time look-up of pertinent data when coding recipes. Pertinent data fields in each of these data collections are shown on the back side of Handout 2.

Implementation of an Integrated Recipe Model

Implementation of this proposed Integrated Recipe Model involves several tasks. The first task is to create related data collections that are linked to the different segments of the Recipe Data Base and the Ingredient File. The next task would involve designing or modifying an existing Recipe Data Base to include pertinent data fields. With the data structures in place, one would be ready to develop a data entry dialog and the computational logic required to capture and process the data. To facilitate evaluation of recipe coding, software should be designed to incorporate diagnostic capabilities. Another important feature to include in a recipe calculation system is the capability of re-calculating nutrient values for all recipes on demand. Total re-calculation is desirable each time a new version of the nutrient data base is installed in a system. Also, re-calculation would be needed for all affected recipes when revised yield factors or refuse factors are available.

Data entry functions should be easy to use correctly, default factors to an "inactive" status, provide look-up support for data linkages, trigger data entry controls such as data edits for validity, and permit recipe modification without having to re-code all information of the basic recipe.

Diagnostic capabilities should be incorporated into the software to evaluate aspects of data coding against standardization data or across all recipes. The validity of coding can be reviewed by comparing the descriptions of all IDs linked to an ingredient. For example, one might compare the names of the ingredient and alternative form with the name of the ID in the Nutrient Data Base, the name of the ID in the Refuse Factors File, and the name of the ID in the Food Inventory File. Cross-references of ingredients and recipes can be useful to identify recipes containing specific ingredients.

The coding of yield factors might be compared across all recipes for a given form of an ingredient if an Ingredient File were not used. Similarly, moisture change factors might be compared across recipes of the same type such as casseroles, cakes, soups, etc.

Using these diagnostic capabilities, inconsistency in data coding over time by different coders can be detected and reconciled. These capabilities are important in any recipe data base system regardless of which calculation method is used.

Benefits of an Integrated Recipe Model

The benefits of an Integrated Recipe Model will be a comprehensive set of features which are suitable for a variety of purposes with simplified recipe coding and maintenance. A consensus on an Integrated Recipe Model will facilitate the development of new data bases of supporting data.

Mixed dishes, coded according to recipes, will probably constitute an increasing proportion of the data records in nutrient data bases as we attempt to reflect data for foods as consumed. The recipe strategy provides a way to reflect ethnic and regional variations, to estimate values for constituents of interest when laboratory analyses are not feasible, and to recalculate nutrient profiles when ingredients change or the nutrient values of the ingredients are up-dated. The expanding use of these calculation procedures will emphasize the essentiality of better data about cooking losses and gains and nutrient retention.

In this proposal of an Integrated Recipe Model, the data maintained in the existing recipe models have been merged and re-organized into a configuration that minimizes data redundancy and coding effort. Only minor modifications in computational strategies have been suggested, but additional enhancements may be warranted. My comments have been limited to the estimation of nutrients in recipes and have not extended to the collection and coding of recipes in dietary intakes records.

The Handouts reflect my thinking at this point and provide a reference point for discussion. Perhaps some of you can identify fields of data that should be added. Others of you may offer other ways to configure the data fields. I welcome all of your suggestions for improvements in my proposal. In closing, I am hopeful that we can, at some point, unify our support for a comprehensive model.

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Handout 1

Data Fields in an Integrated Recipe Model

Loretta W. Hoover, Ph.D., R.D., University of Missouri-Columbia

RECIPE GENERAL INFORMATION

Recipe ID Number
Recipe Variation ID:
- Basic Recipe
- Modification of Basic Recipe:
  - Low Fat
  - Ingredient Substitution

Recipe Name(s):
- Full Production Name
- Abbreviated Production Name
- Menu Name

Handling Loss Percentage(s)
Overall Change Factors:
- Moisture Change
- Fat Change

Nutrient Data Base ID for Fat Change
Recipe Standardization Data:
- Recipe Standardization Status
- Recipe Weight Prior to Cooking
- Recipe Finished Weight
- Weight Per Gallon (lbs)
- Actual Portion(s) Information:
  (multiple records)
  - ID of Portion Size
  - ID of Unit of Measure
  - Number of Measure Units
  - No. of Portions/Portion ID
  - Gram Weight/Portion ID

Calculated Recipe Data:
- Total Weight of Ingredients
- Coded Finished Recipe Weight
- Computed Recipe Yield (%)
- Actual Recipe Yield (%)
- Computed Portion(s) Information:
  (multiple records)
  - ID of Portion Size
  - No. of Portions/Portion ID
  - Gram Weight of Portion

Recipe Coding Diagnostic Information:
- Finished Weight Difference
- Finished Weight Percent Difference
- Recipe Yield (%) Difference
- Diagnostic Portion(s) Information:
  (multiple records)
  - ID of Portion Size
  - Gram Weight Dif./Portion ID
  - No. of Portions Dif./ Portion ID

Yield Factor Nutrient Calculation
Method Flag (Y or N)
Recipe Production Information:
- Recipe Classification(s):
  - ID of Menu Category:
    (Beverage, entree)
  - ID of Diet Category Type:
    (Regular, Low Fat)
- Advance Preparation Code
- Batch Sizes:
  - Minimum
  - Maximum
- Preparation Time:
  (multiple records)
  - ID of Unit of Time
  - Amount of Time
- Cooking Information:
  (multiple records)
  - ID of Cooking Equipment
  - Cooking Temperature
  - Cooking Time:
    (multiple records)
    - ID of Unit of Time
    - Amount of Time

Recipe Serving Information:
(multiple records)
- ID of Portion Size
- No. of Portions/Serving Pan
- Serving Utensil/Portion ID

Recipe Cost/Price/Portion Information:
(multiple records)
- ID of Portion Size
- Ingredient Cost/Portion ID
  (calculated)
- Selling Price/Portion ID
- Mark-up %/Portion ID

Note: All of the data fields associated with "ID of Portion Size" could be positioned as one grouping. They are listed separately for presentation purposes.

Handout 1 (Continued)

Data Fields in an Integrated Recipe Model

Loretta W. Hoover, Ph.D., R.D., University of Missouri-Columbia

RECIPE INGREDIENT INFORMATION:

Recipe ID Number
Recipe Variation ID
Ingredient Sequence No.
Quantity of Ingredient:
 (multiple records)
 ID of Unit of Measure
 Number of Measure Units
 (as stated on recipe)
Links to Ingredient File:
 ID of Ingredient File
 (Optionally could be Food Inventory File ID or Nutrient Data Base ID)
 ID of Alternative form of ingredient "as stated" on recipe from Ingredient File
 ID of Preparation Option of alternative form of ingredient "as stated" on recipe from Ingredient File
Recipe Ingredient Flags:
 Ingredient Type:
 (regular, substitute, sub-recipe, re-usable by-product)
 Immunity to Loss/Gain Adjustment
Recipe Production Information:
 ID of Recipe Preparation Procedures Step

RECIPE NUTRIENTS:

Recipe ID Number
Recipe Variation ID
Proximate and Nutrient Values:
 (multiple records)
 ID of Nutrient
 Nutrient Value per 100 gms

RECIPE PREPARATION PROCEDURES:

Recipe ID Number
Recipe Variation ID
Preparation Information:
 (multiple records)
 ID of Preparation Step
 Text of preparation procedures

Handout 2

Pertinent Data Fields In Other Data Collections
Referenced by an Integrated Recipe Model

Loretta W. Hoover, Ph.D., R.D., University of Missouri-Columbia

Ingredient File:

- ID of Ingredient File
  - (Also, could be Food Inventory ID or NDB ID)
- Description(s) of Ingredient: (multiple records)
  - Full name
  - Abbreviated name
- Commodity Ingredient Flag
- Advance Freezer Withdrawal Code
- Alternative Forms of Ingredient: (multiple records)
  - ID of alternative form "as stated" on a recipe
  - Description(s) of ingredient "as stated" on recipe: (multiple records)
    - Full name "as stated" on recipe
    - Abbreviated name "as stated" on recipe
  - ID of Nutrient Data Base ("as stated" form)
  - EP-->AP Conversion Factor
  - Advance Preparation Flag
  - Weights of Measures: (multiple records)
    - ID of Unit of Measure
      - (Cup, Pint, Wedge, etc.)
    - Gram Weight of Unit of Measure
  - Preparation Information: (multiple records)
    - ID of Preparation Option: (multiple records)
      - (e.g. Baked, served bone-in)
      - Yield Factors: (multiple factors)
        - ID of Type of Yield Factor:
          - Preparation Yield (AP-->EP)
          - Cooking Yield
        - Yield Factor Value (proportion)
    - Consumable Yield: (multiple records)
      - ID of Refuse Component in Served Portion
    - ID of Nutrient Retention Factors
    - ID of Nutrient Data Base (served form)

Optional: Need when Food Inventory ID is not ID of Ingredient.

Food Inventory File:

- ID of Ingredient "as purchased"
- Description of purchased form
- etc.
- etc.

Ingredient-->Food Inventory Cross-Reference:

- ID of Ingredient File
- ID of Food Inventory File
  - ("as purchased" form)

Handout 2 (Continued)

Pertinent Data Fields In Other Data Collections Referenced by an Integrated Recipe Model

Loretta W. Hoover, Ph.D., R.D., University of Missouri-Columbia

Unit of Measure:
- ID Code for Unit of Measure:
  - LB/OZ
  - GM
  - etc.
- Description of Unit of Measure

Portion Size:
- ID of Portion Size:
  - SM
  - RG
  - LG
  - PT
  - etc.
- Description of Portion Size:
  - small
  - regular
  - large
  - patient
  - 100 grams
  - 3 oz
  - child
  - cafeteria
  - etc.

Nutrient Data Base Descriptions:
- ID Number of form (raw or final) of ingredient
- Description of food

Nutrient Data Base Values:
- ID Number of form (raw or final) of ingredient
- Proximate and Nutrient values:
  - (multiple records)
  - ID of Nutrient
  - Nutrient Value per 100 grams

Nutrient Retention Factor Descriptions:
- ID of set of factors
- Description of set of nutrient retention factors
  - (e.g. Legumes, CKD 45-75 min, BLD, DRND, BKD)

Nutrient Retention Factors:
- ID of set of factors
- Nutrient Retention Factor Values:
  - (multiple records)
  - ID of Nutrient
  - Retention Factor Value

Refuse Component Descriptions:
- ID of Refuse Component
- Description of Refuse Component
  - (e.g. bones, bone and fat, peel, etc.)

Refuse Component Factors:
- ID of Ingredient File
  - Refuse Factors:
    - (multiple records)
    - ID of Refuse Component
    - Refuse Factor Value (proportion)

Using the New USDA Formats

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HNIS has implemented new formats for the Survey Nutrient Data Base (NDB) System beginning with the 1994 survey. The new file structures were presented in detail at the 1993 NDB Conference and are in the handout entitled USDA SURVEY NUTRIENT DATABASE SYSTEM. The Survey NDB files include Survey and PDS descriptions, gram weights, measures and nutrient values; Survey recipes; retention factors and descriptions, moisture fat change values and descriptions and nutrient descriptions. They will be released as ASCII delimited files which have been exported from Paradox tables.

The Survey Food Codebook contains the information needed for coding foods and amounts. It consists of 7 files. The Codebook Description file contains food description data. The Include file contains "includes" which are similiar foods with comparable nutrient values and weights such as Wisconsin and New York cheddar cheese. Brand name foods can also be includes. The Codebook Subcode, Subcode Description and Subcode Include files contain information on subcodes. Subcodes are foods which have comparable nutrient values but different weights for the same measure. An example is Hostess cupcakes and Little Debbie Snak Cakes which are subcodes of the code for chocolate cupcake with icing or filling because of their similar nutrient profile. However, each of the brand name foods has a unique weight for the same measure. The PDS codebook files have the same formats as their comparable files in the Survey codebook.

The Gram Weights file contains a weight in grams for each measure description for a particular food item. Weights for similiar foods in the Survey and PDS codebooks are shared. The Measure Description file contains a 5 digit code for each unique measure description. For example 1 cup is measure number 10205.

The Survey and PDS Nutrient files contain nutrient values for the Survey and PDS foods respectively. Multiple nutrient values will exist when necessary to reflect changes that have occured in foods. Each nutrient value has a start date and an end date to mark the effective time period for that value.

The Survey Recipe files control the generation of Survey nutrient values using the PDS and other supporting files. There is a recipe header file and a recipe ingredient file. The recipe header file contains the recipe description and information on changes in moisture and/or fat that occur in cooking and the type of fat, if applicable. The recipe ingredient file contains information on recipe ingredients including the food code and description, amount and retention code.

Other support files include the Retention Factors files, Moisture and Fat Change files and nutrient description files. This is a brief overview of some of the information included in the handout. It lists each file structure and describes the relationships between the files and data items. Since successful use of data depends on an understanding of the data items and their relationship to one another, this is a good place to begin.

In addition to file format changes, there are changes in the size of some of the data items and the addition of new data items. The most notable change is the increase in the size of the Survey food code from 7 to 8 digits.

The new formats for codebook descriptions and weights and measures are much easier to access and manipulate than the previous text format. The ASCII delimited files can be imported into a variety of software packages where the data can be queried and analyzed. Listed here are a few examples of how the data could be used.

SLIDE 1

Potential Uses for Survey and PDS Codebooks

- Create subset databases using food codes and/or descriptions
  - Foods whose descriptions contain the word chicken
  - Foods whose codes begin with 57 (cereals)
- Select and calculate gram weights for selected foods
  - Average grams per surface inch of pizza
- Calculate nutrient values for standard measures for selected foods
  - Sodium content for 1 cup of chicken soups
  - Iron content of 3 oz raw weight of meats
  - Vitamin A content for 1 cup of cold cereals

These are some examples of data records from the Survey NDB files in ASCII delimited format. The indentation indicates the continuation of a single record. In ASCII delimited files, the end of each data value is marked or limited by the use of a special character called a field delimiter. Since alphanumeric data items can contain the same character that is being used as a field delimiter, a different character is used to enclose alphanumeric fields. This is called a string delimiter. Common default delimiters are the comma as a field delimiter and the double quote as a string delimiter. Since commas and double quotes are used in food and measure descriptions, it is necessary to use a different character, the caret (^) symbol, as the field delimiter. The double quotation mark is the string delimiter for the alphanumeric fields. Dates are formatted as MM/DD/YYYY.

SLIDE 2

ASCII Delimited File Format Examples
Food and Measure Descriptions

- Codebook Description

```
11112000^    "Milk, cow's, fluid, lowfat, NS as to percent fat"^
             "MILK, COW'S, FLUID, LOWFAT, NS AS TO % FAT"^
             ""^"1"^4/01/1985^12/31/2010^
```

- Measure Description

```
61706^  "1 piece (1/8 of 7" x 12", approx 3-1/2" x 4")"^
        5/01/1993^12/31/2010^
```

There is no standard format for ASCII delimited files. Although software packages use basically the same specifications for reading and writing ASCII delimited files, there may be differences. Software packages may or may not provide the option of changing some or all of the specifications. The variation in ASCII delimited formats most often affects reading alphanumeric and date type fields correctly.

Specifications for the format of an ASCII delimited file include the character used as a field delimiter, the character used as the string or alphanumeric delimiter, and whether or not all fields or only alphanumeric fields are enclosed with the string delimiter. Software packages may allow the user to specify the format of the date field. This may be done as part of the ASCII delimited file specifications or part of the data base or software specifications. Most software packages will read and write a variety of date formats.

Using software defaults with alphanumeric fields which contain the default delimiters, may result in a loss of data. When the string delimiter occurs within an alphanumeric field, some software packages write the delimiter twice as a way of indicating it is not to be read as a string delimiter.

SLIDE 3

ASCII Delimited File Format Examples
Gram Weights and Nutrients

- Gram Weight

```
11112000^0^0^1^10205^245^4/01/1985^12/31/2010^
11112000^0^0^2^30000^30.6^4/01/1985^12/31/2010^
```

- Survey Nutrient

```
11112000^203^3.339^4/01/1985^12/31/2010^
11112000^394^.06^4/01/1985^12/31/2010^
```

When importing ASCII delimited files, some software packages scan the file to check the length for each field and the number of decimal places in numeric fields. The software package will then create a structure that matches the data. If the software does not, the structure must be created explicitly. In either case the field types, field widths and number of decimal places should be checked against the formats supplied by HNIS. Creating a structure based on viewing the first few records may result in incorrect formats and loss of data. As you can see in this example non-significant zeros and spaces are usually not included, it is not possible by looking at a few records to determine the maxiumum field size or maximum number of decimal places.

The most successful procedure for importing ASCII delimited files (or any other type of file) into software packages or using the files with custom programs includes these steps. First check the file and data format specifications. Second import a variety of test data to check for inconsistencies. Third review the data thoroughly after it has been imported and before you use it.

With the implementation of Trend Analysis in the Survey NDB, the starting and ending dates must be referenced in order to retrieve data accurately. In the Survey NDB files there is a start date and an end date for each record. When data is requested for a specific date a single record is returned. If no date or a range of dates is requested, decisions must be made about the meaning and processing of multiple records.

Slide 4 shows an example of a breakfast cereal which has food changes occurring on three different dates affecting five nutrients. The rest of the nutrient values remain the same. These changes reflect a combination of fortification and reformulation. The Vitamin A value, nutrient code 392, decreases on 04/01/1989 from 1324 to 794. The Vitamin C value, nutrient code 401, increases from 53.0 to 211.6 on 04/01/1987. The values for saturated fat, monounsaturated fat and polyunsaturated fat, nutrient codes 606, 645 and 646, change on 10/01/1989.

SLIDE 4

Survey Nutrient File
Multiple Food Changes to Nutrients

Survey Code	Nutrient Code	Nutrient Amount	Starting Date	Ending Date
57213000	392	1324.0	04/01/1985	03/31/1989
57213000	392	794.0	04/01/1989	12/31/2010
57213000	401	53.0	04/01/1985	03/31/1987
57213000	401	211.6	04/01/1987	12/31/2010
57213000	606	0.81	04/01/1985	09/30/1989
57213000	606	0.82	10/01/1989	12/31/2010
57213000	645	0.37	04/01/1985	09/30/1989
57213000	645	0.42	10/01/1989	12/31/2010
57213000	646	0.52	04/01/1985	09/30/1989
57213000	646	0.58	10/01/1989	12/31/2010

Slide 5 shows a simple selection command using the date of intake as the criteria used to select records. Using the Survey Nutrient file, records are selected for food code equal to 57213000; nutrient codes equal to 392 (Vitamin A), 401 (Vitamin C), 606 (Saturated Fat), 645 (Monounsaturated Fat) and 646 (Polyunsaturated Fat); and starting date less than or equal to the date of intake and ending date greater than or equal to the date of intake.

SLIDE 5

Survey Nutrient File
Data Selection Process

```
Use survey nutrient file

   Select the records with food code =  57213000  and

     nutrient code =  392 or 401 or 606 or 645 or 646  and

     starting date <= intake date and ending date >= intake date
```

Substituting in different dates for the intake date will retrieve different nutrient values as shown in Slide 6. In this example, none of the nutrients changed value more than once. However, that can and certainly will happen.

SLIDE 6

Survey Nutrient File
Data Selection Results

Date of Intake	VIT A 392	VIT C 401	SAFA 606	MUFA 645	PUFA 646
03/15/1987	1324.0	53.0	0.81	0.37	0.52
03/15/1989	1324.0	211.6	0.81	0.37	0.52
06/15/1989	794.0	211.6	0.81	0.37	0.52
10/15/1989	794.0	211.6	0.82	0.42	0.58

Although the formats for the Survey NDB files have changed, the data contained in the files is basically the same. For example, the new Survey Nutrient file can be converted into the format currently in use. This will allow the Survey nutrient data to continue to be used with existing systems.

SLIDE 7

Survey Nutrient File Comparison

Current		New	
Data Item	Format	Data Item	Format
----	---	-----	------
Food Code	N 7	Survey Code	N 8
Food Description	A 51	Nutrient Code	N 5
Water	N 10.3	Nutrient Value	N 10.3
Food Energy	N 10.3	Start Date	Date
.	.	End Date	Date
.	.		
Potassium	N 10.3	SURVEY CODEBOOK DESCRIPTION	
		Survey Code	N 8
		Abbreviated Descriptor	A 60

The current format is fixed field. Each data item is in the same columns for all records. There is one record for each food with all the nutrient values in that record.

In the new format there is one record per food, per nutrient, per date range. Each record is identified by the food code, the nutrient code and the starting and ending dates. The size of the food code has been increased to 8 digits. The size of the nutrient values has not changed. The new Survey Nutrient file does not have the food description in it. All the food description data is now part of the Survey Codebook Description file. The food description data item is called the ABBREVIATED DESCRIPTOR and the size has been increased from 51 to 60 characters.

There are a number of ways to convert the nutrient file in the new format into the current format. It can be accomplished with a data base management or statistical package or with a programming language. Within a data base management or statistical package, the interactive commands or procedural language can be used. The two files needed are the Survey Codebook Description file and the Survey Nutrient file. In each of these files, records are selected for a specific date. The Survey Nutrient file which has one record per food per nutrient is converted into one record per food with all the nutrient values for that food in separate data fields. The two files are linked on Survey food code. In a programming or data base management procedure language it would look something like this.

SLIDE 8

Survey Nutrient File
Format Conversion Process

```
For each record in the Survey Codebook Description File
    where starting date <= selection date and
          ending date   >= selection date

    Save the food code and abbreviated descriptor in memory

    For each record in the Survey Nutrient File
       where food code = saved food code and
             starting date <= selection date and
             ending date   >= selection date

       Save the nutrient value in an array in memory

   Write food code, abbreviated descriptor and nutrient
      values to a record
```

A similiar type process can be used to created printed Survey and PDS codebooks. Each of the codebook files would be imported into a database management package. When a single version codebook is desired, selecting based on date as a first step will reduce the size of the files. The files can then be linked on the data items as described in the handout and a report created. Special purpose codebooks can be easily produced by selecting which foods and data items will be included and by varying the layout of the report.

Version data bases can be extracted for any date for any of all of the Survey NDB files. However the date used must always be a single date to insure that multiple values are not retrieved. For example, there are many ways a version data base could be set up for the calendar year 1994. The data could be selected based on the beginning, ending or middle of the year. Data could be selected based on the values in effect for the longest time period during the year or other more complex algorithms using weighted times.

In summary, the new formats for the Survey Nutrient Database System files will be easier to use and will make it possible to track changes in food data over time. The files are easily imported into software packages where they can be used for many different purposes.

Strategies for Adding and Documenting Data for New Foods

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This work was supported by funding from the Lesotho Highlands Development Authority through the Consortium for International Development, the Ministry of Agriculture of Egypt, and the US Department of Agriculture (Cooperative Agreement #58-319R-3-008).

Introduction: The Need For Suitable Systems For Handling Of Food Intake Data In The International Context

In international nutrition research, there has long been a need for manageable, self-contained systems which can be used to enter, manage and analyze food intake data at the periphery - i.e., close to the site of data collection - and which are based on adequate, well-supported food composition data. Until such systems could be developed, food intake data from developing countries have been very cumbersome to analyze and have generally been doomed to appear either long after the study had been completed or with nutrient estimates based on incomplete and out-of-date food composition analyses. The advances in database development, maintenance and management which have benefitted large clinical trials and population surveys in the US and Europe in the last decade or so are only recently becoming accessible in reasonable formats to investigators in other parts of thee world.

There are several requirements for adequate systems for international use. First, the system should be based on state-of-the-art food composition information with the possibility for regular updating as new information becomes available. Second, the entire system should be self-contained for local analysis capability - that is, it should not require that data be sent elsewhere for analysis, and it should be manageable on currently available microcomputer systems. Third, a great deal of flexibility in adding new recipes and altering existing recipes is required, including the ability to specify or change fat and water retention/loss factors. And fourth, it should be possible to add new foods and nutrient information from published or other sources. With these four requirements met, one would have a manageable, state-of-the-art system which would be adaptable to a wide variety of food environments and cuisines.

Currently Available Systems: Worldfood And FIAS/FFDEAP

Currently, there are to our knowledge only two currently available systems which meet most of these requirements. One of these has been very recently released by the University of California, Berkeley, the "Worldfood System" (Calloway and Murphy, 1994). Based on work done in the mid-1980s in the context of the USAID-supported Nutrition CRSP (Collaborative Research Support Program) in Mexico, Egypt and Kenya, this system matches country-specific foods to a mini-list of 195 foods based on their nutrient composition. The system is menu-driven and includes complete values for 53 nutrients; the data are from published food composition tables, with imputed values if none are available. The user accesses a country-specific food list, which the software cross-references to the appropriate food item on the mini-list, or in the case of mixtures to multiple mini-list foods. The system has thus far been designed for six countries: Mexico, Kenya, Egypt, Indonesia, Senegal and India. Guidelines are provided for updating or creating new cross-reference files. The cost is quite reasonable, and the price structure includes a deep discount for investigators in developing countries.

The other system which meets most of the requirements outlined above is the one we have been utilizing in a variety of populations, namely the Food Intake Analysis System (FIAS) developed by the USDA and the University of Texas, and its companion system for analysis of food frequency data, the Food Frequency Data Entry and Analysis Program (FFDEAP). These systems are more expensive and require more computer capability, but are well-maintained and are based on a much more extensive food and ingredient list. The database contains both the Primary Data Set (approximately 2500 foods selected from the USDA Handbook 8 and corresponding nutrient profiles for 30 nutrients) and the Survey Nutrient DataBase which contains approximately 6000 of the most commonly consumed foods in the United States population, including both single ingredients and multiple ingredient recipe foods. The menu-driven system allows direct data entry and on-line coding. The system allows creation of new user recipes and modification of existing recipes including the alteration of water and fat retention/loss factors. While Version 1.0 of FIAS did not allow for the addition of new foods, the current version (2.3) has this capability.

We have been using the FIAS system for several years in international work, and have with the support of both USDA and University of Texas staff found ways to adapt the system to the needs of specific dietary patterns and food preparation methods. This paper will present some of that work, including the solutions to specific problems we have encountered. Specifically, I will focus on two pieces of research: the Lesotho Highlands Health Survey, Phase IA, and a currently ongoing project which is focused on the development of a pilot for a national food consumption monitoring system for Egypt, in cooperation with the Agricultural Research Center in Cairo.

The Lesotho Highlands Health Survey (LHHS), Phase IA, was carried out in 1991-92 in a remote highlands area in the mountains of Lesotho in Southern Africa (Muramoto & Harrison, 1993). The work was done through the Consortium for International Development (Tucson, AZ) under a contract with the Lesotho Highlands Health Authority. The purpose of the study was to provide a comprehensive baseline assessment of human health in a region to be affected by the construction of a large dam and reservoir. This construction is part of a very large water development project which will include several dams, reservoirs, tunnels and other construction and will ultimately change the course of important rivers which have their headwaters in the Maluti Mountains, enabling Lesotho to sell its precious natural resource, water, to neighboring South Africa for agricultural production. Because of the potential for environmental change resulting from the project resulting in changes in human health and animal health, the Government of Lesotho commissioned the LHHS to provide a baseline set of data.

The survey was carried out in two sequential cross-sectional surveys, one in winter and the other in summer, on two separate but equivalent samples including 588 households and more than 1600 individuals. The survey included collection of data on anthropometric measurements, clinical signs of nutritional deficiencies, household food security, food frequencies on all household members, and quantitative 24-hour recalls of food intake on selected household members. FIAS, Version 1.0, was utilized for analysis of the 24-hour recall data and FFDEAP for organization and analysis of the food frequency data.

The second study which has provided us with experience in adapting FIAS is an ongoing effort to assist the Agricultural Research Center of the Ministry of Agriculture in Egypt to develop a food consumption monitoring system for the country (Galal and Harrison, 1992). This work is being carried out with financial support from the US Department of Agriculture under the National Agricultural Research Program of the Ministry of Agriculture. The pilot phase of this effort, which is now in the field, is collecting data on a representative sample of approximately 7000 households in rural and urban areas of five of Egypt's 24 governorates. The design includes questions regarding food acquisition and food security, a household-level food frequency qustionnaire, and quantitative 24-hour recalls on a child under

12 years of age if present and that child's mother or female caretaker. We are utilizing FIAS, Version 2.3, modified specifically for the Egyptian context, for analysis of the 24-hour recall data.

In both of these studies, interviewing protocols, data collection instruments, data entry protocols and recipe development required development specifically within the context of the culture, language, food supply, and food preparation techniques of the population. In particular, the ability to add and document new foods and recipes to the database is critical. I would like to review several of the problems we have encountered and the ways in which we have approached solving them or approximating solutions. These problems arise mainly due to the generation of large files of user recipes, the necessity to change the naming of foods and/or units of measurement to local convention in order to reduce error; and variation in nutrient composition of basic ingredients and of prepared foods.

1. The need to create a <u>relatively large number of user recipes</u> to accurately represent local food preparation techniques poses several challenges. One is that multiple creators of recipes may create recipes with only slight differences and with different or the same names. This required, in both projects, frequent (daily or almost daily) reconciliation of the recipe files with discussion and decision making about similar recipes. Another problem is that the FIAS program requires scrolling through the entire user recipe file in order to locate a user recipe; they cannot be searched or sorted within the program. We solved this problem in Lesotho by creating a system for grouping recipes by number, with those based on similar ingredients sharing adjacent numbers.

2. <u>Naming conventions</u> in other countries, even in translation, differ from those employed in the US-based systems. We found that creation of user recipes was the best way to handle these discrepancies in order to minimize error, rather than relying on field data collection staff to continually make the translational effort. For example, "rice" in the Egyptian cuisine is always made with fat or oil, closer to a simple "rice pilaf" than to plain "rice" in the US diet. Rather than require data entry personnel to remember that "rice" is really something else in the system, it was sensible to create a user recipe entitled "Egyptian rice".

Names of measures, even when the measures were part of the program, also differed. For example, in Lesotho what is called a "baby spoon" in FIAS is called a "teaspoon" and what FIAS calls a "teaspoon" is locally termed a "dessert spoon". This did require a constant effort to convert quantities, the responsibility for which we placed on data entry staff rather than field data collectors.

3. The <u>inability to create recipes using household measures</u> rather than gram weights has been a cumbersome problem. It is tempting to try as much as possible to modify existing recipes instead, but this works only if the overall recipe weight does not change by more than 5%. Our approach to dealing with this constraint, in both locations, was a test kitchen to derive the proper weights as well as water and fat retention factors.

4. <u>Water retention factors</u> in some staple dishes in the cuisine in Lesotho exceeded the limits of the program. Many of the "soft" or more liquid maize or sorghum porridges consumed in Lesotho have considerable amounts of water added in preparation; compared to the dry ingredient, the final cooked food will increase in volume nine-to ten- fold. We simply increased the quantity of water or the water retention factor until the recipe approximated our test kitchen data.

5. <u>Fermented foods</u> are common in many African diets, and fermentation is a preparation process not available in FIAS. In Lesotho, the most common fermented foods are "sour" soft corn porridge (*motoho ea poone*) and home-brewed beer (*joala ba sesotho*). To construct appropriate recipes within FIAS, we relied

heavily on consultation with local experts from the Nutrition Unit of the Lesotho Ministry of Health and the Foods Sciences Department of the Lesotho Agricultural College for data on nutrient composition of the prepared foods. The major problems in recipe construction center around the presumed changes in nutrient bioavailability as a result of the fermentation process, including improvements in protein quality and in the availability of micronutrients including zinc, calcium magnesium, iron and vitamin B_{12}. Our procedure for creating approximately valid recipes was to first prioritize nutrients in terms of their importance for later data anlaysis based on information about the common nutritional problems in the area. Then we kitchen-tested the recipe for water retention, compared the nutrient composition of the recipe as calculated by FIAS to published nutrient composition data from Africa. The existing recipe was then modified so that the final FIAS-generated nutrient composition matched the published source with regard to the highest-priority nutrients (for these recipes in this setting, our first priorities were for niacin, thiamine and riboflavin). To achieve the desired alcohol content for *joala*, grain alcohol was simply added into the recipe until the alcohol content of the FIAS-generated nutrient data matched the alcohol content from published sources.

6. Perhaps the most difficult problem we have faced is that the USDA nutrient composition database reflects levels of nutrients which meet the US legal standards for enrichment and fortification for products which are enriched or fortified under US law. A wide variety of wheat-, rice- and corn-based products are affected, as well as milk and margarine. We have over the last several months been working to create a non-enriched, non-fortified version of the nutrient database using Handbook 8 values for non-enriched flour and baked products and fortification/enrichment standards for other products. The University of Texas is currently working with us to make the programming modifications to assure retention of these values through recipe calculations.

Conclusions

It is very clear that the interest in and demand for adequate systems for analysis of food consumption data in developing countries far exceeds the resources for development of these systems locally and even regionally at this time. In the interim, FIAS provides a useable if not perfect option which with fine-tuning and adjustment we have found quite servicable. This fine-tuning, however, requires careful test kitchen procedures and knowledgeable professionals in terms of food composition at the field and data management levels.

References

Calloway DH and SP Murphy. Overview of the UCB Worldfood Dietary Assessment System. Berkeley, CA: 1994.

Galal, OM and GG Harrison. Development of a Pilot Food Consumption Monitoring System for Egypt. Proposal submitted to the US Department of Agriculture, 1992.

Muramoto, ML and GG Harrison. Nutrition Survey, Lesotho Highlands Health Survey, Phase IA. Final Report Submitted to the Lesotho Highlands Development Authority. Tucson, AZ: Consortium for International Development, 1993.

Addendum

Final Report of the Committee on Citing Nutrient Databases

Suzanne P. Murphy, *University of California, Berkeley*

The ad hoc Committee on Citing Nutrient Databases was active from 1991 until 1993. Interim reports were given to participants of the 17th and 18th National Nutrient Databank Conferences. In 1993, the final recommendations were mailed to editors of 62 journals which publish human nutrition research results. Copies of the cover letter, the recommendations, the committee membership, and the journal list follow. Sample letter to an editor regarding procedures for citing nutrient databases:

Dear Editor:

The attendees of the 16th and 17th National Nutrient Databank Conferences recognized the need for recommendations concerning appropriate descriptions of the sources of food composition data used in published human nutrition research papers. A committee of databank users and developers was formed to address this issue. The attached recommendations to authors reflect the consensus of this committee. We urge you to circulate these suggestions (or a modification appropriate to your journal) as part of the guidelines to authors and reviewers. We believe that the use of dietary data as a research tool will be more credible if researchers provide readers with accurate and complete information about their sources of nutrient data. We have included two examples, and would be happy to work with you to adapt the citation style if you wish. Please feel free to contact me if you would like more information.

Sincerely,

Suzanne P. Murphy, Ph.D., R.D.
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Enc'l: Recommendations for Describing Nutrient Databases
Committee Membership List

Recommendations for Describing Nutrient Databases
Used in Published Research

Basic information:

Authors should give the name, version number, and release date of the nutrient database (or software system) and cite or footnote the vendor or developer. [Developers of nutrient databases should supply users with an appropriate citation; at a minimum, the citation should give the name and address of the vendor.] Include a brief statement concerning the handling of missing nutrient data for foods: whether values are imputed and an evaluation of the impact of any missing values on dietary totals for the nutrients of interest.

Additional information required:

1. If the nutrient database is not publicly available from the developer, authors should describe all sources of nutrient data and give citations (or, if extensive, indicate the citations are available by contacting the authors).

2. If modifications (additions, changes, corrections, imputations) were made to an existing nutrient database, authors should describe these modifications and give citations for all sources of data (or, if extensive, indicate the citations are available by contacting the authors).

3. If multiple databases were used, authors should describe the sources following the above guidelines.

Examples:

1. For a USDA data base with values imputed by the researchers: "The nutrient content of diets was calculated from values on USDA's Nutrient Database for Standard Reference, Release 10, 1992 (ref. n). Missing values for the nutrients of interest were imputed by the authors."

Ref. n: Human Nutrition Information Service, United States Department of Agriculture. USDA Nutrient Database for Standard Reference, Release 10, 1992. Springfield VA:National Technical Information Service. (computer tape)

2. For a vendor-distributed database: "The nutrient content of diets was calculated using [system name, version number, year] (ref. n). This database [has no missing values; has few (less than x%) missing values for the nutrients of interest; may underestimate intakes of nutrients x,y,z due to missing values]."

Ref. n: Organization name and address.

Members of the Committee on Citing Nutrient Databases who participated in drafting these recommendations:

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DSIR, New Zealand

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Jean Hankin
University of Hawaii

Loretta Hoover
University of Missouri, Columbia

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INFOODS, MIT

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Jean Pennington
FDA, Washington DC

Grace Petot
Case Western Reserve University

Patricia Pillow
M.D. Anderson Cancer Center

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Harvard University

Carol Windham
Utah State University

Journals receiving the "Recommendations for Describing Nutrient Databases" (please notify Suzanne Murphy, 510-642-5572, if any relevant journals are missing):

American Journal of Clinical Nutrition
American Journal of Preventive Medicine
American Journal of Epidemiology
American Journal of Health Promotion
American Journal of Public Health
Annals of Epidemiology
Annals of Internal Medicine
Appetite
Archives of Internal Medicine
Arteriosclerosis and Thrombosis
Australian Journal of Nutrition and Dietetics
British Journal of Nutrition
British Medical Journal
Cereal Chemistry
Circulation
Diabetes
Diabetes Care
Cancer
Cancer Causes and Control
Cancer Epidemiology Biomarkers & Prevention
Cancer Research
Ecology of Food and Nutrition
Epidemiology
European Journal of Clinical Nutrition
Food Technology
Gastroenterology
Geriatrics
Gut
International Journal of Epidemiology
Journal of the American College of Nutrition
Journal of the American Dietetic Association
Journal of the American Geriatrics Society
Journal of the American Medical Association
Journal of the American Oil Chemists' Society
Journal of the Canadian Dietetics Association
Journal of Cancer Education
Journal of Clinical Epidemiology
Journal of Clinical Investigation
Journal of Food Composition and Analysis
Journal of Gerontology
Journal of the National Cancer Institute
Journal of the New Zealand Dietetic Association
Journal of Nutrition
Journal of Nutrition Education
Journal of Obesity and Weight Regulation
Journal of Parenteral and Enteral Nutrition
Journal of Pediatrics
Journal of Renal Nutrition
Lancet
Medicine and Science in Sports and Exercise
Metabolism: Clinical and Experimental
New England Journal of Medicine
Nutrition and Cancer
Nutrition in Clinical Practice
Nutrition Research
Nutrition Reviews
Nutrition Today
Pediatrics
Preventive Medicine
Science
Topics in Clinical Nutrition
Trends in Food Science and Technology

APPENDICES

Poster Abstracts

USDA Survey Nutrient Database System: System Components and File Formats

Exhibitors

Conference Committees

Participants

Poster Abstracts

Poster 1

BEYOND THE FOOD EXCHANGE SYSTEM LISTS: A NEXT GENERATION DIET MANAGEMENT SYSTEM

*Darwin Dennison, EdD, CNS, Department of Health Behavioral Sciences, State University of New York at Buffalo, Dominic Galante, MD, MS, Kathryn F. Dennison, EdD, and Janice Cochran, MS, RD eligible, DINE Systems, Amherst, New York

This poster will present the programmatic organization and preliminary findings of a new quantification system for use by nutrition professionals for dietary counseling and management of consumers' diets. The purpose was to develop a quantified, nutrient-based, food guidance system and database designed to reduce the nutritional risk profile. Current food guidance procedures, including the American Dietetic Association and American Diabetic Association's Food Exchange Lists, USDA/HHS Food Guide Pyramid, and other systems have practical and empirical limitations. The proposed quantification system compares what is eaten with the meal plan and provides an analysis which makes the complexities of diet and energy balance much easier to understand and apply. The system is adaptable to varying energy and nutrient needs and can be used in both individual and group counseling settings. Formative and process evaluation data will be presented as well as the results of focus study data.

Poster 2

TIMELY FEEDBACK FOR DIET INTERVENTION SUPPORT: A UNIQUE FEATURE OF THE MDRD STUDY.

Fran L. Jones, Frani M. Averbach, Eric J. Bruno, Rebecca J. Meehan, JoAnn Naujelis, Monica E. Yamamoto, and the MDRD Study. MDRD-Nutrition Coordinating Center (NCC), University of Pittsburgh, Pittsburgh, PA

Large diet intervention trials, particularly multi-centered, long-term studies, typically collect dietary data solely for research purposes. A few have provided interventionists with periodic but infrequent (_ 1/yr) information on study group intakes only. In contrast, the Modification of Diet in Renal Disease (MDRD) Study[1] regularly provided Study dietitians with reports from individual patient's bimonthly 3-day food records. This data provided important feedback for patient counseling. In fact, based on an MDRD participant survey, 94% rated nutrient intake reports as useful to very useful in meeting their Study goals. Food-nutrient intake reports from "priority" food records could be provided in as little as two-weeks if the Nutrition Coordinating Center (NCC) received the food record at least 16 days before the patient's next visit. Intake reports for the quarterly adherence assessment visits were automatically tagged as "priority". However, a dietitian could declare other reports as "priority" by noting this on the food record and providing answers to NCC data questions within three days. In exceptional, limited cases, "emergency" intake reports could be provided within a few days.

To facilitate the "priority" report process, several elements were installed. All data queries and intake reports were transmitted to dietitians via electronic mail. A "Query" phone hotline, staffed by trained food coding specialists, received answers for the NCC data queries and fielded dietary data questions. To flag and track upcoming priority records, internal data flow systems and reports were created. Over the course of follow-up, a total of 10,567 intake reports were generated. Of the 6889 (65% of total) follow-up records

that were received at least 16 days before the next visit, 3677 (35% of total) were tagged as "priority" and expedited for intervention support.

[1] The MDRD Study tested the effects of diet and blood pressure interventions in patients with chronic renal disease.

Poster 3

COMPARISON OF THE DIETARY GUIDELINES AND THE QUALITY OF MENUS PLANNED IN MISSISSIPPI CHILD CARE CENTERS

Charlotte Beckett Oakley, PhD., RD, Dept. of Home Economics, University of Mississippi, University, MS, Anne K. Bomba, PhD, Dept. of Home Economics, University of Mississippi, University, MS, Kathy B. Knight, PhD, RD, Dept. of Home Economics, University of Mississippi, University, MS, Sylvia H. Byrd, PhD, RD, Dept. of Food Science and Technology, Mississippi State University, Mississippi State, MS

Healthy People 2000: National Health Promotion and Disease Prevention Objectives identifies children as a high priority group on the agenda of health care concerns for this decade and states that little is known about the nutritional status of children enrolled in child care facilities, and little research has been conducted on the foodservice operations of child care facilities in general. The purposes of this study were to collect information from Mississippi's licensed child care centers on their foodservice operations relative to: 1) participation in the United States Department of Agriculture (USDA) sponsored Child Nutrition Program and 2) the nutrient content of the planned menus. Licensed child care centers in Mississippi were surveyed using a questionnaire. Approximately 10% of the licensed child care centers in Mississippi were randomly selected for study. Each center selected was sent a questionnaire which included a request for cycle menus currently being used in the facility. One hundred eighteen child care centers responded and were divided into groups based on participation in the USDA-sponsored child care food program. Nutritionist III nutrient analysis software version 7.0 was used for the menu analysis. Mean values of the nutrients were tested for differences using the analysis of variance procedure with Statistical Analysis Systems software. Percent calories from carbohydrates, protein, and fat were calculated for comparison to Dietary Guidelines' recommendation concerning these nutrients. Seventy-five percent of the facilities reported participation in the USDA-sponsored child nutrition program. Eighty-seven percent of the centers reported following the Dietary Guidelines when planning menus. Results of this study supported the claim that nutrient quality of menus may be inconsistent in licensed child care facilities. The mean amounts of energy, protein, total carbohydrates, polyunsaturated fats, cholesterol, vitamin A, thiamin, niacin, vitamin B6, pantothenic acid, vitamin E, potassium, and zinc were significantly lower ($P<.05$) for facilities that reported participating in the child care food program. However, mean values for vitamin D and calcium were higher. Percent calories from protein was 19.2% for menus from the participating group of facilities compared to 17.8% for the facilities not enrolled in the program, although the mean amount of protein in the menus was not higher. Percent calories from fat (40.8%) was also higher in the participating facilities' menus while total energy and saturated fats were not higher, and the cholesterol content of the lunches was lower. The mean fat levels for all centers exceeded the recommendation of no more than 30% of total kcalories from fat over time with 40.8% for centers that participated in the program and 38% for those that did not. Similarly, both groups were higher in protein and lower in carbohydrate than recommended by the Dietary Guidelines.

Poster 4

TIME REQUIREMENTS FOR DOCUMENTING DIETARY DATA FOR RESEARCH APPLICATIONS: THE MDRD STUDY EXPERIENCE

Monica E. Yamamoto, Frani M. Averbach, Fran L. Jones, Marian Olson and the MDRD Study. MDRD-Nutrition Coordinating Center (NCC) University of Pittsburgh, Pittsburgh, PA

Data documentation is standardly used in research for data verification and critical detail retrieval. The Modification of Diet in Renal Disease (MDRD) Study, a 15 center diet and blood pressure interventions trial, collected time required for Study dietitians' activities including dietary data documentation procedures "with" and without the participant (post-contact). This latter time included second documentation by a trained colleague, food information retrieval, and responses to MDRD-NCC data queries. Recorded documentation times and differences by participant characteristics were examined.

Overall, documentation time for 3-day food records declined 22% (41 to 32 minutes) from baseline to 3 years. "With participant" time fell 35% (26 to 17 minutes) while post-contact time remained unchanged (18.8 to 18.5 minutes). Documentation times were remarkably consistent by diagnosis, diet group and marital status. However, significant differences by age, race, gender, education and visit were noted. At baseline, data for the oldest (60+ y/o) needed the most post-contact time. After year one, the youngest (<40 y/o), who required the shortest "with participant" time, needed the most post-contact time to complete documentation of their food record data. Data for whites (vs. blacks) in year one and women (vs. men) in the first and last year needed more post-contact time while dietary data for those in the lowest educational level (_9 yrs.) consistently required more post-contact time.

Time required for dietary data documentation has been used as a rationale for eliminating dietary data for studies. Our findings show time (and, therefore, cost) reductions for dietary data documentation over the course of follow-up. Additional time reductions may be possible with further intake report training and support of the subgroups identified.

Poster 5

USING THE NUTRIENT RETENTION METHOD IN RECIPE CALCULATIONS FOR TRADITIONAL NEW MEXICAN FOODS

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Nutrient values were needed for traditional New Mexican foods for use in the New Mexico Aging Process Study and the NM Survey of Health in Elderly Hispanics. Recipe calculations using the nutrient retention method were performed using the Food Intake Analysis System (FIAS), version 2.0 (Univ. of Texas Health Science Center, Houston). FIAS provides the user with access to the USDA Recipe Program, and its accompanying USDA databases: Primary Nutrient Database, Survey Database and Nutrient Retention Factor Database. Recipes were calculated for: chile sauce (red and green), enchiladas (beef, chicken and cheese), burritos (beef, bean and chicken), chile rellenos, chile stew (red and green), tacos (beef and chicken) and tamales. These foods either were not in the Survey Database, or the Survey Database version was not typical of New Mexico preparation and consumption. For example, the USDA red chile sauce contains tomatoes, while New Mexican sauce does not. Traditional New Mexican chile sauces contain fat and flour, the USDA versions do not; using the Survey Database codes would omit an important local source of dietary fat. The chile sauces were kitchen-tested for taste and traditional representation. The chile sauces, chile stews and rellenos were kitchen-tested for yield, portion size and fat and moisture retention. Nutrient values for the chile sauces were added to the FIAS database for use as ingredients in other recipes. The recipe calculations used the nutrient retention method to simulate steps in actual food preparation. The resulting recipe files were used in coding and analyzing 24-hr recalls and 3-d diet records for the aging studies. Nutrient composites were created and seven items were added to the Block/NCI food frequency questionnaire. The nutrient retention method gives a practical approach to the development of nutrient values for regional foods for use in dietary assessment research. (Supported by NIH AG-02049 and AG-10941)

Poster 6

ANALYSIS OF VITAMIN K_1 (PHYLLOQUINONE) IN CORE FOODS FROM THE US TOTAL DIET STUDY.

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In addition to its well-established role in the hemostatic system, vitamin K serves an important function in bone and cartilage metabolism. This has led to a renewed interest in expanding the limited food composition data for vitamin K1 (phylloquinone). Food samples obtained from the FDA-US Total Diet Study were analyzed by an HPLC method that incorporates postcolumn reduction of the quinone followed by fluorescence detection of the hydroquinone form of the vitamin. Green and leafy vegetables still appear to be the predominant dietary source of this vitamin, followed by certain vegetable oils that are derived from vegetables or seeds containing large concentrations of vitamin K1. The reduced form of vitamin K1 (saturated side chain) is observed in significant quantities in foods that have been subjected to partial hydrogenation or that contain ingredients that have been partially hydrogenated. However, these data derived from wet, chemical analysis do not indicate the relative biological availability of vitamin K and the reduced form of vitamin K from these sources. Certain foods are low in vitamin K1 content, including butter and tomato-based dishes, but may make significant contributions to total dietary intake if consumed in large quantities in the American diet. Other food sources have been shown to contain negligible amounts of vitamin K1 (such as certain meats, brewed beverages, soft drinks and alcoholic beverages). These data expand and improve the quality and the quantity of the vitamin K Provisional Table and will be used to prioritize future analysis for this vitamin. Applications of these data will include estimates of the vitamin K intake at the national level using the National Food Consumption Survey. The validity of the 3-day diet records and a FFQ for estimates of dietary intake for this vitamin are now feasible and should result in a better understanding of this vitamin at the nutritional level.

Poster 7

MODIFYING A CURRENT NUTRIENT DATABASE FOR USE WITH DIETARY ASSESSMENT DATA FROM 1971-75.

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Longitudinal nutrition studies often require baseline estimates of nutrient intakes using dietary data collected many years ago. Such is the case for the NHANES I Epidemiologic Followup Study, with baseline 24-hour recall data collected in 1971-75. Although nutrient analyses were performed using a nutrient database that was appropriate at the time, the quantity and quality of food composition data have improved significantly over the intervening 20 years. Thus, in order to (1) extend the number of nutrient intake estimates (from 18 to 35), (2) fill in the large number of missing nutrient values, and (3) use data from more accurate analytic methods, we modified a current nutrient database (the UCB Minilist) for use with dietary data from the early 1970's. Necessary modifications included: adjusting enrichment standards to those in use at the time of the dietary data collection; extending the number of entries for unenriched grain products; adjusting fortification levels; and changing the types of fat used in processed and home-made food items. Comparisons of dietary nutrient totals (using data for 6337 persons 45 years of age and older) for 18 nutrients in common on the original NHANES I nutrient database and the UCB Minilist, indicated lower values using the Minilist nutrient data for iron (due primarily to lower analytical data for meats), and higher values for thiamin (due in part to revised values for pork products, and in part to missing data on the NHANES I database). Correlation coefficients ranged from 0.86 (for thiamin) to 0.99 (for energy). Mean values for estimates of other nutrient intakes were similar to those reported from more recent surveys. We conclude that the quantity and quality of nutrient intake estimates from previously-collected dietary data can be increased by modifying current nutrient databases to reflect standards and practices in use at the time of the data collection. Supported by NHLBI Grant HL48530.

Poster 8

NUTRIENT LOSSES AND GAINS IN THE PREPARATION OF FOODS. NLG-PROJECT.

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The objective of the FLAIR Eurofoods-Enfant Project, funded by the Food Linked Agro-Industrial Research (FLAIR) Programme of the Commission of the European Communities, Directorate-General XII, is to improve the quality and compatibility of food consumption and food composition data in Europe. One of the activities of the Project was to support the work on nutrient losses and gains factors.

The Nutrient Losses and Gains Project (NLG) was established in Wageningen in 1983. The aim of the project was to collect data related to nutrient losses and gains in the preparation of foods with a view to recommend factors for use with the calculation of the nutrient content of foods and recipes.

This work has resulted in three papers: Nutrient losses and gains in the preparation of foods (an overview report), Nutrient losses and gains references, and Yields for foods and dishes in Europe, which are combined in one report in The National Administration report series, Rapport 32/94.

NLG-factors were suggested for 11 vitamins on recipe level. These were related to 3 cooking methods and to 2 food groups (one general and one for meat and poultry). The factors were based on available nationally used factors. Three different computer programs were used in the calculation of nutrients for 6 dishes. The calculated results were compared with analyzed results. The result of this limited test is rather mixed. Further differentiation of the NLG factors is required.

Poster 9

THE USE OF STANDARDIZED CODE RULES AT TUFTS NUTRIENT DATA CENTER

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Standardized data collection and coding are critical components of dietary assessment. At Tufts Nutrient Data Center (TNDC) dietary data collectors complete a thorough training and certification program before interviewing study participants. To insure consistency and reproducibility in data entry, dietary data coders at TNDC also complete a detailed training program, which focuses on the use of the Tufts Nutrient Database, coding brand name items, using additional sources of nutrient data, and math formulae for calculating portion sizes. Even with these detailed efforts, we are often presented with food records and 24-hour recalls that contain insufficient information about food items, details that the participant does not know.

Nutrient data centers use defaults when specific information is missing from a food record. TNDC has termed these defaults "Code Rules", which appear on line as part of the interactive coding program. The Code Rules are also printed and are organized by food group. Each Code Rule is documented with a date and bibliographic reference. Code Rules are reevaluated annually and new Code Rules are developed as needed. Since Code Rules may be study specific they must be researched for individual studies and populations.

While the quality of nutrient data is researched and discussed extensively, there has been little discussion on specific coding practices such as Code Rules. A small study comparing food records coded by TNDC and the NCC-Minnesota (Poster Eleventh National Nutrient Databank Conference) showed that nutrient calculation discrepancies were primarily due to code rule differences and interpretation of ambiguous data rather than actual nutrient database differences. Because coding practices can dramatically affect dietary data results, database users must work together to develop and standardize Code Rules in an effort to improve the quality of dietary data.

The purpose of this poster presentation is to increase awareness of the use of Code Rules among researchers and database users. This presentation will demonstrate how code rules appear in our interactive database and will explain the development of study specific code rules. The TNDC Code Rule Manual will be offered at a nominal cost in order to make public one set of code rules in an effort to generate discussion about these coding issues and reevaluate this important aspect of dietary assessment, with the ultimate goals of 1) developing a standardized approach to making code rules and 2) publishing a standardized Code Rule Manual to be used by all databases to insure reproducibility and consistency of dietary data in research studies.

Poster 10

NUTRITION ATTITUDES, DAIRY INTAKE AND DIETARY QUALITY MEASURED BY BRIEF QUESTIONNAIRES

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This study describes two new questionnaires: 1) a 51 item dairy questionnaire (DQ) which assesses dairy product preference, use and knowledge and health and nutrition beliefs and; 2) a self-scored 49 item food habits questionnaire (FHQ) which assesses dietary quality. The food pyramid was used for overall organization of FHQ with the addition of an 'other' category (alcohol, fast foods, high calorie desserts, drinks and snacks). Three hypotheses were examined: first, that attitudes and knowledge about the relationship of nutrition to health (DQ) items would be reflected in healthy food choices; second, that high dairy product preference (DQ items) would relate to overall dietary quality (FHQ scores); and third, that self-reported dietary quality (FHQ scores) would predict healthier nutrient amounts measured by one day food records (1DFR). The DQ, FHQ and 1DFR were completed by 247 normal weight and obese women and men (x age=54) in the ongoing RENO Diet Heart Study. Within each pyramid category foods were grouped by health related nutrients which they had in common. The internal reliabilities (Cronbach's) were .86 for FHA and .70 for DQ. Correlation coefficients computed between FHQ dietary quality scores and selected 1DFR nutrients indicated strongest relationships (r's=-.22 to -.56) between low total dietary quality, use of fats and oils and high fat dairy with percent of calories from fat in the diet. High total fat in the 1DFR was most strongly related to a low score in the 'other' catagory of FHQ (r=-.37). Factor scores from the DQ (nutrition concern, dietary efficacy and butter substitute) explained 44% of the variance in overall dietary quality. The DQ factor termed 'nutrition concern' uniquely explained significant variance (approx. 10% each) in 1DFR total calories, total fat and percent fat after subject variables were accounted for. The DQ factors termed 'high dairy use' and 'foods prevent disease' predicted higher 1DFR calcium levels. Low fat dairy preference from the DQ correlated with lower kcal ($p<.05$) and fat ($p<.01$) intake on the 1DFR and higher dietary quality on the FHQ ($p<.01$) whereas high fat dairy preference had the opposite effects. The results indicate that health attitudes and dietary quality assessed by questionnaire can predict selected food choices and may provide a simple, reliable approach to measuring certain health related nutrients.

USDA SURVEY NUTRIENT DATABASE SYSTEM

SYSTEM COMPONENTS AND FILE FORMATS

U.S. Department of Agriculture
Human Nutrition Information Service

USDA SURVEY NUTRIENT DATABASE SYSTEM COMPONENTS

Survey Food Codebook
- Codebook Description File
- Codebook Include File
- Codebook Subcode File
- Codebook Subcode Description File
- Codebook Subinclude File
- Codebook Measure Description
- Codebook Gram Weights File

PDS Codebook
- Codebook Description File
- Codebook Include File
- Codebook Subcode File
- Codebook Subcode Description File
- Codebook Subinclude File
- Codebook Measure Description
- Codebook Gram Weights File

Survey Nutrient File

Primary Nutrient Data Set (PDS)

Survey Recipe Files
- Recipe Header File
- Recipe Ingredient File

Retention Factors File
Retention Factors Description File

Moisture and Fat Change File
Moisture and Fat Change Description File

Nutrient Description File

USDA SURVEY NUTRIENT DATABASE SYSTEM COMPONENTS

The data files described in this document are designed and developed for nutritional analysis in USDA Food Consumption Surveys.

Formats for all system files include the name of the field, followed by the type of field (N=numeric, A=alphanumeric, and D=date), the length of each field, including decimals, and a * symbol to indicate that a field is indexed. The files described here will be released in ASCII delimited format and thus will not have indexes. Indexes are identified in this document to show the order of records within the Human Nutrition Information Service database system. Each of the fields in the ASCII released format wil be separated by a caret (^) symbol and character fields will be enclosed in double quotation marks.

SURVEY FOOD CODEBOOK

The SURVEY FOOD CODEBOOK contains information needed for coding foods and amounts. For each food on the data base, there is a food identification code, a long and short description of the food, a set of measures for the food, and gram weights for those measures. Some codes may have "includes" for similiar foods with comparable nutrient values and weights. Some codes may also have subcodes for foods with comparable nutrient values but different weights for the same measure.

The SURVEY FOOD CODEBOOK consists of 7 files. They are the **CODEBOOK DESCRIPTION**, **CODEBOOK INCLUDE**, **CODEBOOK SUBCODE**, **CODEBOOK SUBCODE DESCRIPTION**, **CODEBOOK SUBINCLUDE**, **CODEBOOK MEASURE DESCRIPTION** and **CODEBOOK GRAM WEIGHTS** files. The **CODEBOOK DESCRIPTION**, **CODEBOOK INCLUDE**, and **CODEBOOK GRAM WEIGHTS** files and the 2 subcode files, **CODEBOOK SUBCODE** and **CODEBOOK SUBINCLUDE**, are linked together by the 8 digit survey code. The **CODEBOOK MEASURE DESCRIPTION** file is linked to the **CODEBOOK GRAM WEIGHT** file by the measure description number and the **CODEBOOK SUBCODE DESCRIPTION** file is linked to the **CODEBOOK SUBCODE** file by the subcode number.

CODEBOOK DESCRIPTION FILE (CBDES) contains the primary code description and the abbreviated version of the description.

Survey Code	N 8*	
Descriptor	A 200	
Abbreviated Descriptor	A 60	
Status	A 1	whether or not code is discontinued
Fl oz/Wt oz	A 1	type of ounce used with food
Start Date	D	date code started
End Date	D	date code no longer to be

		used
Last Modified Date	D	date of last change

CODEBOOK INCLUDE FILE (CBINCL) contains "includes" (similiar foods with comparable nutrient values and weights for the same measure) associated with a particular code. For example, Wisconsin, New York, Hoop and Tillamook cheeses are includes with the code for cheddar cheese because of their similar nutrient profile. Brand name foods can also be includes. Each include for the same code number has its unique line number for easier management.

Survey Code	N 8*	
Include Line Number	N 2*	unique line number for each include
Include Description	A 80	
Start Date	D	
End Date	D	
Last Modified Date	D	

CODEBOOK SUBCODE FILE (CBSUBCOD) contains information directly related to a unique subcode. This file and the next 2 files (**CODEBOOK SUBCODE DESCRIPTION** and **CODEBOOK SUBINCLUDE**) are new concepts introduced into the codebook. They will allow the separate listing of brand name food items and special case food items for the purpose of identifying unique weights for the same food measure for foods with the same nutrient profile. For example, Hostess cupcakes, Drake's Yodels, Tasty-Kake cupcakes and Little Debbie Snak Cakes are subcodes of the code for chocolate cupcake with icing or filling because of their similar nutrient profile. However, each of the brand name cupcakes has a unique weight for the same measure.

Survey Code	N 8*	
Subcode Number	N 7*	linked to **CBSCDES** file
Nutrients	A 2	specifies whether nutrients are available for this product
Start Date	D	
End Date	D	
Last Modified Date	D	

CODEBOOK SUBCODE DESCRIPTION FILE (CBSUBDES) contains a code for each unique brand name item or special case food item.

Subcode Number	N 7*	linked to the **CBSUBCOD** file
Subcode Descriptor	A 60*	
Start Date	D	
End Date	D	
Last Modified Date	D	

CODEBOOK SUBINCLUDE FILE (CBSUBINC) describes the includes for a subcode.

Survey Code	N 8*	
Subcode Number	N 7*	linked to **CBSCDES** file
Seq Number	N 2*	unique line number
Include Descriptor	A 60	description of subinclude
Start Date	D	
End Date	D	
Last Modified Date	D	

CODEBOOK WEIGHTS AND MEASURES

Two files--**CODEBOOK MEASURE DESCRIPTION** and **CODEBOOK GRAM WEIGHTS**--are shared by the SURVEY and PDS CODEBOOKS. Sharing these files between the two codebooks avoids duplication of measure descriptions and insures that the weights for a PDS food which is similar to a Survey food contain the same weights and measure descriptions.

CODEBOOK MEASURE DESCRIPTION FILE (CBMDES) contains a 5 digit code for each unique measure description that can be found in the codebook. The same measure can be used for many different foods. For example, the "cup" measure, #10205, is used for many codes.

Meas Descr Number	N 5*	unique measure description code, linked to the **CBGMWT** file
Description	A 120*	
Start Date	D	
End Date	D	
Last Modified Date	D	

CODEBOOK GRAM WEIGHTS FILE (CBGMWT) contains weight information for each measure description for a particular food item. All weights are in grams. Weights for similar foods in the Survey and PDS codebook are shared. Other weights are unique to either a PDS or Survey food.

Survey Code	N 8*	
Subcode Number	N 7*	either a brand name food item or special case item, linked to the **CBSCDES** file
NDB Code	N 5*	
Seq Number in Wt Category	N 2*	unique line number for each measure weight
Meas Desc Number	N 5*	unique measure description code, linked to the **CBMDES** file
Gram Weight	N 8.3	weight of food item
Start Date	D	
End Date	D	
Last Modified Date	D	

☞ NDB code may be expanded by one or two additional digits

PDS CODEBOOK

The PDS CODEBOOK contains information on codes and subcodes for the Primary Nutrient Data Set, short and long name descriptors for each food, code and subcode inclusions, and gram weights for various portion sizes. Two files which are components of the Survey Codebook--**CODEBOOK MEASURE DESCRIPTION** and **CODEBOOK GRAM WEIGHTS**--are also included in the PDS Codebook. Other files included are the **CODEBOOK DESCRIPTION, CODEBOOK INCLUDE, CODEBOOK SUBCODE, CODEBOOK SUBCODE DESCRIPTION** and **CODEBOOK SUBINCLUDE.** These files will have the same formats as their comparable files in the Survey Codebook, but will contain data relative to PDS foods.

SURVEY NUTRIENT FILE

The SURVEY NUTRIENT FILE contains nutrient values for foods to be used in analysis of food intakes from the USDA Nationwide Food Consumption Surveys and DHHS National Health and Nutrition Examination Surveys. Multiple nutrient values will exist, when necessary, to reflect changes that have occurred in foods. Included with each set of values will be a start and end date reflecting the effective time period covered by the values.

Survey Code	N 8*	
Nutrient Code	N 5*	identifies a nutrient, linked to **Nutrient Description** file
Nutrient Value	N 10.3*	
Start Date	D	
End Date	D	

SURVEY NUTRIENT FILE SYSTEM COMPONENTS

USDA maintains an automated system for producing the Survey Nutrient File. Files included in this system are the **PRIMARY NUTRIENT DATA SET** and **PDS CODEBOOK**, **RECIPE HEADER** and **RECIPE INGREDIENT**, **RETENTION FACTORS** and **RETENTION FACTORS DESCRIPTION**, **MOISTURE AND FAT CHANGE** and **MOISTURE AND FAT CHANGE DESCRIPTION**, and **NUTRIENT DESCRIPTION**. Multiple values will exist for foods, nutrients or other designated variables in these files, when necessary. Each set of values will include a start and end date reflecting the effective time period covered by the values.

PRIMARY NUTRIENT DATA SET (PDS) contains nutrient values for foods needed to create the Survey Nutrient File. The primary source of data for the PDS is the USDA Nutrient Data Base for Standard Reference, which is the output from the USDA Nutrient Data Bank System. Nutrient values are added for nutrients not in the Standard Reference File and complete nutrient profiles are added for foods not in the Standard Reference.

NDB Code	N 5*	identifies a food in the Nutrient Data Bank System
Nutrient Code	N 5*	
Nutrient Value	N 10.3*	
☛ Change Code	A 3	reason for change in a nutrient value when multiple values exist for the same nutrient
Source Code	N 2	type of data value based on-analytical, calculated, label
Start Date	D	
End Date	D	
Date Added	D	

* Changes will be classified as due either to fortification, reformulation, or other agricultural, food processing or marketing change.

RECIPE FILE

The Recipe File controls the generation of the Survey Nutrient File using the PDS and other supporting files. Each survey food code is linked to one or more PDS foods through a set of recipe codes. Links to single PDS items are treated as one-component recipes. The Recipe File has been separated into two files-- **RECIPE HEADER** and **RECIPE INGREDIENT**.

RECIPE HEADER FILE contains information on changes in moisture and/or fat that occur during cooking, expressed as a percentage (plus or minus) of the total weight of the uncooked recipe. If there is a fat gain or loss during cooking, the type of fat used in cooking is also designated in this file.

Survey Code	N 8*	
Food Name	A 240	
Moisture Fat Code	N 8	code that specifies a moisture change, linked to **Moisture Fat Change File**
Moisture Change	N 5.1	percentage gain/loss in moisture during cooking
Fat Change	N 5.1	percentage gain/loss in fat during cooking
Moisture Fat Change Code	A 3	reason for change in a moisture or fat gain/loss when multiple values exist
Fat Type Code	N 8	fat used in cooking
Fat Type Change Code	A 3	reason for change in fat used in cooking when multiple codes exist
Start Date	D	
End Date	D	
Last Modified Date	D	

RECIPE INGREDIENT FILE contains information on recipe ingredients--ingredient descriptions with their corresponding codes, measure descriptions for each ingredient, weight of each measure in grams (excluding refuse weight), and appropriate retention codes for the ingredients.

A maximum of two amount descriptors is allowed for an ingredient. For example, a recipe may call for 1 cup + 1 tablespoon of flour. The information required to code 1 cup is listed in the first group of fields with a "1" after the field names. The information for coding 1 tablespoon is listed in the second group of fields with a "2" after the field names.

Survey Code	N 8*	
Ingredient Seq Number	N 2*	unique line number for each ingredient
Ingredient Code	N 8*	either a PDS or Survey food, linked to **Survey Nutrient** file or **PDS** file
Ingredient Subcode	N 7*	either a brand name food item or special case item, linked to **CBGMWT** file
Ingredient Name	A 60	
Flag	N 2	signals special conditions for an ingredient
Ingredient Change Code	A 3	reason for change in an ingredient when multiple codes exist for the same sequence number
Amount 1	N 11.3	specifies the part of a portion size
Measure 1	A 3	type of measure, such as c for cup
☛ Dimension 1_1	N 7.4	ruler length
☛ Dimension 1_2	N 7.4	ruler width
☛ Dimension 1_3	N 7.4	ruler height
Measure Desc Code 1	N 5	unique measure, linked to **CBMDES** and **CBGMWT** files
Amount operator	A 1	indicates the addition to (+) or subtraction from (-) the second ingredient to the first ingredient
Amount 2	N 11.3	
Measure 2	A 3	
☛ Dimension 2_1	N 7.4	ruler length
☛ Dimension 2_2	N 7.4	ruler width
☛ Dimension 2_3	N 7.4	ruler height
Measure Desc Code 2	N 5	
Gram Weight	N 11.3	weight of ingredient
Weight Change Code	A 3	reason for change in ingredient weight, if multiple weights exist for the same ingredient
Retention Code	N 4	food category with factors for calculating vitamin and mineral retentions during cooking, linked to **Retention Factors** file
Retention Change Code	A 3	reason for change in retention code when multiple values exist
Start Date	D	
End Date	D	
Last Modified Date	D	

☛ Ruler measures are used to estimate gram weights of pieces of food, such as a wedge of cheese. Dimension fields are filled in for food measures not included in the **CODEBOOK GRAM WEIGHTS FILE**. A computer program calculates gram weight based on dimensions in these fields.

RETENTION FACTORS FILE contains factors for calculating the retention of vitamins and minerals during cooking. The factors, expressed as a percentage of the nutrient retained, are organized into food categories according to cooking method for food categories. Each food category is assigned a code for computer access, designated the retention code.

Retention Code	N 4*	food category with factors for vitamin and mineral retentions during cooking, linked to **Retention Factors** file
Nutrient Code	N 5*	
Factor	N 5.2*	percentage nutrient retained during cooking
Change Code	A 3	reason for change in a retention code when multiple values exist for same food category
Start Date	D	
End Date	D	
Last Modified Date	D	

RETENTION FACTORS DESCRIPTION FILE contains descriptions associated with each retention code in the Retention Factors File.

Retention Code	N 4*
Food Category Desc.	A 200
Food Category Desc. (abbrev.)	A 60
Start Date	D
End Date	D
Last Modified Date	D

MOISTURE AND FAT CHANGE FILE contains information on moisture and/or fat changes that have occurred during cooking for current survey recipes. Survey codes for current recipes serve as moisture and fat codes. The purpose of this file is to provide guidelines for assigning moisture or fat gain or loss percents to new or modified recipes. Additional information and fields may be included int this file in the future.

Moisture/Fat Code	N 8*	
Moisture Change	N 5.1*	percentage gain/loss during cooking
Fat Change	N 5.1*	percentage gain/loss during cooking
Change Code	A 3	reason for change in a moisture or fat percentage when multiple values exist for the same food
Start Date	D	
End Date	D	
Last Modified Date	D	

MOISTURE AND FAT CHANGE DESCRIPTION FILE contains descriptions of foods associated with each moisture or fat code in the Moisture and Fat Change File.

Moisture/Fat Code	N 8*
Food Description	A 200
Food Description (abbrev.)	A 60
Start Date	D
End Date	D
Last Modified Date	D

NUTREINT DESCRIPTION FILE contains the names and codes for nutrients included in the Survey Nutrient, PDS, and Retention Factors Files.

Nutrient Code	N 5*
Nutrient description	A 30
Nutrient Description (abbrev.)	A 5

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