Recipe Calculations for NFCS Data Base

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The U.S. Department of Agriculture (USDA) recently developed an automated system to create nutrient data bases for appraising the nutrient content of food intakes by individuals reported in dietary surveys. The Human Nutrition Information Service used the system for the first time in early 1985 to create the nutrient data base for appraising intakes from the Continuing Survey of Food Intakes by Individuals (CSFII) and will use it again to create the nutrient data base for the 1987 Nationwide Food Consumption Survey (NFCS). The system uses the USDA Nutrient Data Base for Standard Reference (1) as the major source for nutrient values, and it includes procedures for calculating the nutrient content of recipes based on nutrient data for the individual components. This paper describes the recipe calculation method and how it operates within the framework of the new computer system.

THE COMPUTER SYSTEM

A computer program, which forms the nucleus of the system, creates the survey nutrient data base, calculating the nutrient content of recipes as needed. This program and the following data sets make up the new system (Figure 1).

Primary Nutrient Data Set for Food Consumption Surveys. The Primary Nutrient Data Set for Food Consumption Surveys (PDS) contains nutrient values for all food items needed to create a survey nutrient data base, including all items used as ingredients in recipes. The food components for which data are included are listed in Table 1.

Most of the data come from the USDA Nutrient Data Base for Standard Reference. Some changes and additions to data from the Standard Reference Data Base were made. Changes were made to reflect current data soon to be used in the revision to Agriculture Handbook No. 8 (2) if the newer values differed substantially from the older values. Food groups in which these changes were made include beef, beverages, sugars and sweets, bakery products, and fish. Nutrient values were added as needed for nutrients that are not in the Standard Reference Data Base (e.g., dietary fiber), and complete nutrient profiles were added for missing food items. If analytical data were not available, the added values were imputed from other forms of the foods, or estimates were derived from data for similar foods.

All items from the Standard Reference Data Base carry the Standard Reference identification numbers, referred to as NDB numbers. Added food items have been assigned special NDB numbers. The PDS currently contains data for 2,032 foods. Data are expressed as the amount of nutrient in 100 grams of the edible portion of a food.

Table of Nutrient Retention Factors. This data set contains the factors for calculating retention of 18 vitamins and minerals during cooking. It is based primarily on the "Table on Percent Retention of Nutrients in Food Preparation" (3) but contains several additional specific categories of foods and cooking methods. Because analytical data on nutrient retention are not available for all nutrients in each specific category, missing factors were estimated to complete the table. Each category is assigned a code for computer access.

Recipe File. This data set controls the generation of a survey nutrient data base using the PDS and the table of retention factors. The items to be included in a survey data base are designated and survey food codes assigned before this file is constructed. In this file, each survey food code is linked to one or more PDS items through a set of recipe codes. Links to single PDS items are treated as one-component recipes. The information required for each recipe is listed below:

1. Recipe components.
   a. Names.
   b. NDB numbers.
   c. Weights of the components in grams, excluding the weight of any refuse.
   d. Retention codes, where applicable.

2. 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.

3. Percent yield of the recipe. This is the final weight of the cooked recipe, expressed as a percentage of the uncooked weight. The percent yield is not used in the recipe calculation but is used for the following edit check: Yield = 100 ± moisture change ± fat change.

4. The NDB number for the type of fat (only for recipes with a fat change).

The recipe file contains approximately 4,450 items: one item for every food listed in the survey code book for the Continuing Survey of Food Intakes by Individuals. Approximately half are one-component recipes--direct links to single items on the PDS. If the food code manual is revised for future surveys, the recipe file will be revised accordingly.

USDA Nutrient Data Base for Individual Intake Survey. This data set is the system's output and is the nutrient data base created for analysis of food consumption survey data. All nutrient values come from the PDS--either directly or through recipe calculations. The program transfers survey food codes to this file from the recipe file as nutrient values are placed here for each item. Nutrient values are expressed on the basis of 100 grams edible portion. This data base may also be used as an input file to the recipe calculation program because values calculated

from recipes may be used for ingredients in other recipes. For example, in the data base created for the CSFII, values for cornbread were calculated from a recipe and subsequently used in calculating values for frozen dinners in which cornbread was an ingredient.

RECIPE CALCULATION METHOD

The recipe calculation method used in the new system is a modification of the procedure described in Bulletin ARS 62-13, "Procedures for Calculating Nutritive Values of Home-Prepared Foods: As Used in Agriculture Handbook No. 8, 'Composition of foods---raw, processed, prepared,' Revised 1963" (4). The method described in that bulletin calls for applying vitamin retention factors to the total recipe nutritive values. For the new system, the method was modified to include retention factors for minerals and to apply retention factors to vitamin and mineral values for each recipe component. This change permits using different retention factors for different components and was made because nutrient retention information is more readily available for individual foods than for mixed dishes.

The calculation procedure involves seven basic steps:

1. Determining the weight in grams of each ingredient and subtracting the weight of any inedible part, such as bone. USDA publications are used as sources of data on weight-volume relationships (5,6,7) and refuse (5,6) of ingredients. This step is not a part of the automated procedure.

2. Determining the nutrients in the specified weight of each ingredient. Nutrient values for 100-gram portions of ingredients are stored in the Primary Nutrient Data Set for Food Consumption Surveys.

3. Applying retention factors to vitamin and mineral values where losses may occur during cooking. Retention factors are contained in the Table of Retention Factors.

4. Determining total uncooked weight of the recipe by summing weights of the ingredients.

5. Determining nutrients in the total recipe by summing nutrient values for the ingredients.

6. Adjusting the total values to account for changes in moisture and fat during cooking. Moisture may be lost through evaporation or drippings, or it may be gained through absorption. The total weight of the recipe and the total moisture value are adjusted at this step. (Vitamin and mineral losses are calculated in step 3.) Fat may be lost through drippings or gained through absorption during frying. Fat changes affect total weight, energy, total fat, and fatty acids and sometimes also affect cholesterol, minerals, and fat-soluble vitamins. These values are adjusted at this step. Information on the amount of moisture and fat changes during cooking are taken from USDA publications (4,8) or are

derived from unpublished materials used in the development of Agriculture Handbook 8 revisions (2,6).

7. Converting nutrient values for the total recipe to the 100-gram basis. Steps 2 through 7 are performed by the computer program.

To illustrate the procedures and how they involve the system data sets, here are the calculations for a sample recipe--flounder fillet, breaded, fried.

Recipe information entered into the Recipe File:

Recipe Components	NDB No.	Retention Code	Weight of Edible Part
1. Flounder, raw	80180	2310	907.2 g
2. Egg, raw	01123	0103	50.0 g
3. Milk	01077		15.2 g
4. Bread crumbs, dry	74750	0305	100.0 g
5. Salt	89630		5.5 g

Moisture change = -20%
Fat change = +8%
Yield = 88%
Fat NDB No. = 04031 (vegetable shortening absorbed during frying)

The recipe program locates each NDB number on the Primary Nutrient Data Set, calculates the nutrients for the specified weight, and applies the appropriate set of retention factors to the resulting nutrient values if a retention code has been designated. Calculations for thiamin are presented below as an example.

	NDB Number	Thiamin in 100 grams (from PDS)		Weight		Thiamin in recipe portion		Retention factor		Thiamin (corrected)
		mg		g		mg				g
1.	80180	0.050	X	907.2 / 100	=	0.454	X	.85	=	0.386
2.	01123	0.087	X	50.0 / 100	=	0.044	X	.85	=	0.037
3.	01077	0.038	X	15.2 / 100	=	0.006			=	0.006
4.	74750	0.350	X	100.0 / 100	=	0.350	X	.75	=	0.262
5.	89630	0.000	x	5.5 / 100	=	0.000			=	0.000

The remaining steps in the recipe calculation procedure are illustrated in Table 2 for energy and five nutrients. The weight and nutrient values for the individual ingredients are summed, and moisture and fat changes are calculated by multiplying the total weight by the input data for "Moisture change" and "Fat change." The nutrient data for the type of fat absorbed during frying is accessed in the PDS by the NDB number entered for "Fat NDB No.," and the individual nutrients in the fat are calculated for the amount of fat absorbed. These values are applied to the subtotals to determine the weight and nutrient content of the cooked recipe, and all nutrient values are converted to the 100 gram basis for storage in the survey nutrient data base.

Recipe Report. In addition to the survey data base created by the program, a recipe report is generated for each recipe. The sample recipe report for the founder fillet is presented in Figure 2. The first part of the report contains the input information. Names of the individual components taken from the PDS are printed next to the name from the input record and can be reviewed to check the NDB numbers. This feature was adapted from a program used in the USDA Lipid Nutrition Laboratory in Beltsville, MD.

AVAILABILITY AND BENEFITS

The nutrient data base created for the CSFII will be available to the public sometime during 1986. The other data sets used by this new automated system will also be made available for public use.

A major benefit of this system to USDA is the ability to automatically create and update nutrient data bases for food consumption surveys. An important part of the automated process is calculation of the nutrient content of recipes. An equally important benefit to USDA and the users of USDA's food consumption survey data is the machine-readable documentation of the recipes used in those calculations.

REFERENCES

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7. Fulton, L., E. Matthews, and C. Davis. 1977. Average Weight of a Measured Cup of Various Foods. U. S. Dept. of Agriculture, Home Econ. Res. Rep. No. 41, 26 pp.

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Table 1. Food Components in the PDS

Nutrient	Units
Energy	Kilocalories
Moisture	Grams
Protein	Grams
Fat	Grams
Total saturated fatty acids	Grams
Total monunsaturated fatty acids	Grams
Total polyunsaturated fatty acids	Grams
Carbohydrate	Grams
Calcium	Milligrams
Iron	Milligrams
Magnesium	Milligrams
Phosphorus	Milligrams
Potassium	Milligrams
Sodium	Milligrams
Zinc	Milligrams
Copper	Milligrams
Vitamin C	Milligrams
Thiamin	Milligrams
Riboflavin	Milligrams
Niacin	Milligrams
Vitamin B6	Milligrams
Folacin	Micrograms
Vitamin B12	Micrograms
Vitamin A	International Units
Vitamin A	Retinol Equivalents
Carotene	Retinol Equivalents
Vitamin E	Alpha-tocopherol Equivalents
Cholesterol	Milligrams
Alcohol	Grams
Total dietary fiber	Grams

Table 2. Selected Food Components in Flounder Fillet, Breaded, Fried

	Weight	Energy	Moisture	Total Fat	Saturated Fatty Acids	Mono unsaturated Fatty Acids	Poly unsaturated Fatty Acids
	g	Kcal	g	g	g	g	g
1.	907.2	717	737.6	7.2	1.8	1.8	2.7
2.	50.0	79	37.3	5.6	1.7	2.2	.7
3.	15.2	9	13.3	.5	.3	0.1	.0
4.	100.0	392	6.5	4.6	1.0	1.6	1.5
5.	5.5	0	0.0	0.0	0.0	0.0	0.0
Subtotals	1,077.9	1,197	794.7	17.9	4.8	5.7	4.9
Moisture change	-215.6		-215.6				
Fat Change	+86.2	+762		+86.2	+21.6	+38.4	+22.5
Yield	948.6	1,959	579.1	104.1	26.4	44.1	27.4
per 100 Grams	100.0	207	61.0	11.0	2.8	4.6	2.9

Figure 1. System Components

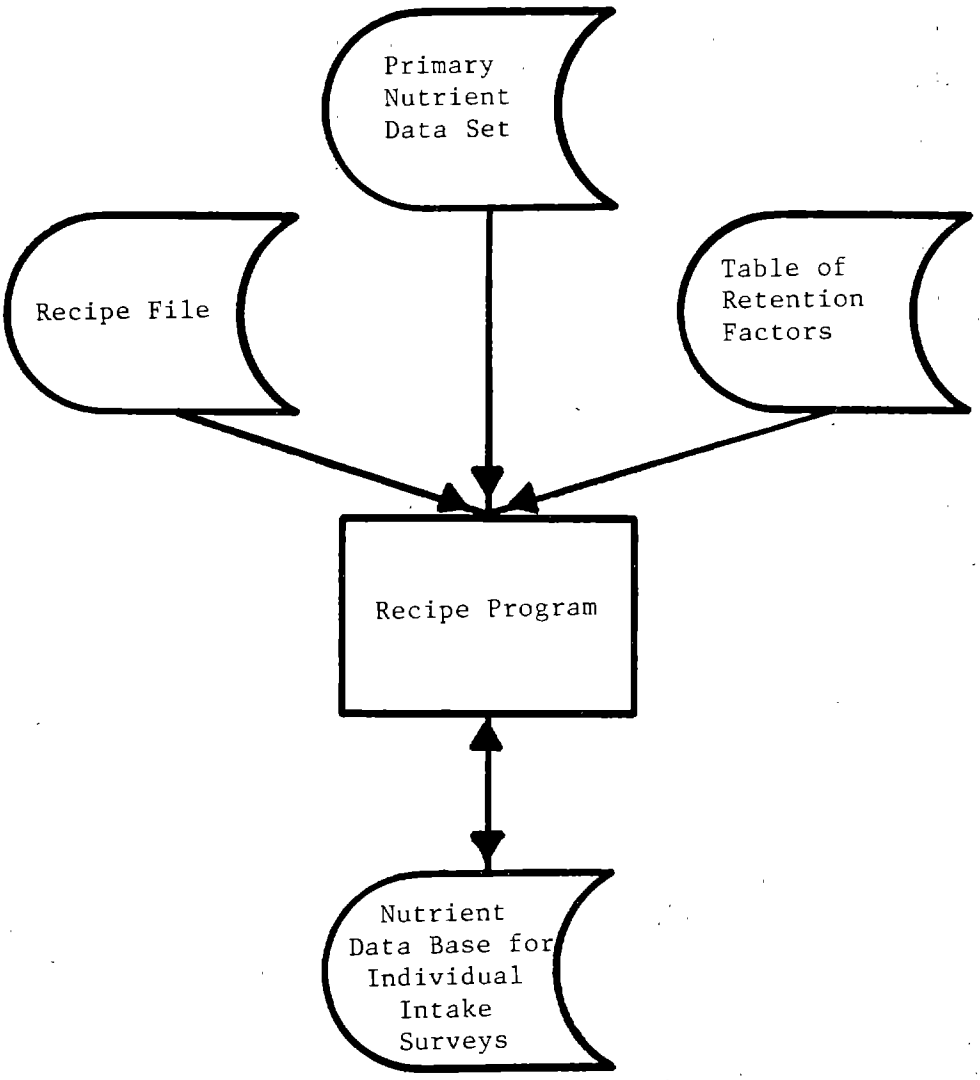

Figure 2. Recipe Report

NOVEMBER 25, 1985 INDIVIDUAL SURVEY NUTRIENT RECORD CREATED FROM STANDARD REFERENCE DATA BASE PAGE 1

FLOUNDER, FILLET, BREADED, FRIED YIELD: 88.0 MOIS CHANGE:-20.0 FAT CHANGE 8.0 FAT ID : 4031 FC: 261-1514

ADD	FLAG	COMP	NDB_NO	INGREDIENT_INPUT_NAME	STD_REF_NAME	RETENTION	MEASURE	GRAMS	PERCENT
		1	80180	FLATFISH,FLOUNDER,RAW	FLATFISHES,RAW	2310	2 LB	907.200	84.164
		2	1123	EGG,RAW	WHOLEEGG FRESHFROZEN	103	1	50.000	4.639
		3	1077	MILK	3.3% FAT WHOLE MILK	0	1 TBSP	15.200	1.410
		4	74750	BREAD CRUMBS,DRY	BREADCRUMB,DRY,GRATE	305	1 C	100.000	9.277
	5	5	89630	SALT	SALT	0	1 TSP	5.500	0.510

COMPONENTS	WEIGHT G	ENERGY CAL	MOISTURE G	PROTEIN G	FAT G	SAT. F.A. G	MONO. F.A. G	POLY. F.A. G
1 FLATFISH,FLOUNDER,RAW	907.200	716.687	737.553	151.502	7.258	1.814	1.814	2.722
2 EGG,RAW	50.000	78.959	37.285	6.070	5.575	1.674	2.228	0.725
3 MILK	15.200	9.339	13.374	0.500	0.508	0.316	0.147	0.019
4 BREAD CRUMBS,DRY	100.000	392.000	6.500	12.600	4.600	1.050	1.580	1.470
5 SALT	5.500	0.0	0.011	0.0	0.0	0.0	0.0	0.0
SUBTOTALS:	1077.900	1196.986	794.723	170.672	17.940	4.854	5.769	4.935
MOIS/FAT CHANGE:	-129.348	762.291	-215.580	0.0	86.232	21.558	38.373	22.507
YIELD:	948.552	1959.276	579.143	170.672	104.172	26.412	44.142	27.441
PER 100 GRAMS:	100.000	206.554	61.055	17.993	10.982	2.784	4.654	2.893

COMPONENTS	CARBO G	CALCIUM MG	IRON MG	MAGNESIUM MG	PHOSPHORUS MG	POTASSIUM MG	SODIUM MG	ZINC MG
1 FLATFISH,FLOUNDER,RAW	0.0	108.864	7.258	272.160	1769.039	3102.624	707.615	4.536
2 EGG,RAW	0.600	28.050	1.045	6.145	90.050	64.950	69.150	0.720
3 MILK	0.708	18.149	0.008	2.043	14.197	23.028	7.448	0.058
4 BREAD CRUMBS,DRY	73.400	122.000	4.100	38.000	141.000	152.000	736.000	0.640
5 SALT	0.0	13.915	0.005	6.545	3.300	0.220	2131.690	0.0
SUBTOTALS:	74.708	290.978	12.416	324.892	2017.586	3342.821	3651.903	5.954
MOIS/FAT CHANGE:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YIELD:	74.708	290.978	12.416	324.892	2017.586	3342.821	3651.903	5.554
PER 100 GRAMS:	7.876	30.676	1.309	34.251	212.702	352.413	384.998	0.628

Figure 2--Con.

COMPONENTS	COPPER MG	VIT C MG	THIAMIN MG	RIBOFLAVIN MG	NIACIN MG	VIT B6 MG	FOLACIN MCG
1 FLATFISH,FLOUNDER,RAW	1.814	0.0	0.386	0.431	15.422	1.388	89.813
2 EGG,RAW	0.031	0.0	0.037	0.143	0.029	0.057	24.375
3 MILK	0.002	0.143	0.006	0.025	0.013	0.006	0.760
4 BREAD CRUMBS,DRY	0.204	0.0	0.262	0.315	4.320	0.036	31.850
5 SALT	0.024	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTALS:	2.075	0.143	0.691	0.914	19.785	1.487	146.798
MOIS/FAT CHANGE:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YIELD:	2.075	0.143	0.691	0.914	19.785	1.487	146.798
PER 100 GRAMS:	0.219	0.015	0.073	0.096	2.086	0.157	15.476

COMPONENTS	VIT B12 MCG	VIT A IU	VIT A RE	CAROTENE RE	A-TOCO. EQ. MG	CHOLEST MG	ALCOHOL G	TO.D.FIBER G
1 FLATFISH,FLOUNDER,RAW	9.798	385.560	115.668	0.0	5.443	453.600	0.0	0.0
2 EGG,RAW	0.657	260.000	78.000	0.0	0.370	273.800	0.0	0.0
3 MILK	0.054	19.152	4.712	0.456	0.014	2.067	0.0	0.0
4 BREAD CRUMBS,DRY	0.0	0.0	0.0	0.0	0.820	1.000	0.0	1.400
5 SALT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTALS:	10.509	664.712	198.380	0.456	6.647	730.467	0.0	1.400
MOIS/FAT CHANGE:	0.0	0.0	0.0	0.0	12.504	0.0	0.0	0.0
YIELD:	10.509	664.712	198.380	0.456	19.150	730.467	0.0	1.400
PER 100 GRAMS:	1.108	70.076	20.914	0.048	2.019	77.009	0.0	0.148

FAT USED: SHORTNNG,REG,SOY/COT

INTERNATIONAL SOURCES OF NUTRIENT COMPOSITION DATA

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Why do investigators and clinicians in the US, where we are supplied with good and ever-improving food composition data, need to know more about data sources from other countries? I think there a four reasons:

1. There is an increasing interest in the nutritional status of ethnic population subgroups, especially those people who have immigrated to the U.S. but continue to consume the foods of their country of origin. The Vietnamese and Hatian refugees are examples of groups who may receive a substantial portion of their nutrients from foods not commonly consumed in the U.S. and therefore not included in the U.S.D.A. data.

2. There is a greater availability of international foods in the American food supply and a greater dietary diversity among the population in general. Food intake records frequently include foods not in the U.S.D.A. tables.

3. American investigators are becoming increasingly involved in international nutrition studies. In my experience, anthropologists are the most frequent solicitors of food composition information.

4. Most database systems now available make it possible to add data for foods not originally included which may be of particular interest in a database application.

What are the problems of using international nutrient data in order to fill gaps in databases available to us?

1. Sources of international data are difficult to identify. Currently there is no complete bibliography of nutrient data. The bibliography accompanying this presentation depended for a large part on a first draft prepared by Will Rand and INFOODS, for which I am grateful. Presumably this problem, the lack of a comprehensive bibliography, will be eliminated through their efforts in the near future.

2. Once you know that a publication, like those included in the bibliography, exists, it is sometimes very difficult to obtain a copy. Many of these publications are out of print. The INFOODS bibliography will include information concerning the source and cost of many publications.

3. Even with a publication in hand, the interpretation of the data can be a problem. Most tables are published in the country's indigenous language, although many have English versions or English indexes. One can often translate the nutrient names, the column headings, but the food names are usually a problem unless you speak the language.

4. The layout of the tables vary from publication to publication. All information may be in a single table or may be broken up into subtables. Foods may be arranged alphabetically (which is little help if you are unfamiliar with the alphabet) or may be arranged by food groups. These groupings may be different, however, than those to which one is accustomed, eg. olives listed as a fruit. (Olives appear to be neither a fruit or a vegetable in the U.S.D.A. Handbook 8 series!)