Recipe Calculations – Nutrient Retention Factor Method

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Introduction

The Human Nutrition Information Service (HNIS) of the U.S. Department of Agriculture uses an automated system to create nutrient data bases for appraising the nutrient content of food intakes reported by individuals in dietary surveys. The system uses the USDA Nutrient Data Base for Standard Reference, the basic data set which contains all nutrient values published in Agriculture Handbook No. 8. It is updated continually. The system includes processes for calculating the nutrient content of recipes based on nutrient data for the individual components. The procedure that we use for calculating recipes is called the nutrient retention factor method, and today I will explain that procedure.

Data Set Files

To begin, a number of supporting data set files are used by the computer program: the Primary Nutrient Data Set for Food Consumption Surveys, the USDA Nutrient Data Base for Standard Reference, the Table of Nutrient Retention Factors, and the Recipe File.

The Primary Nutrient Data Set for Food Consumption Surveys (PDS) contains nutrient values for all food items needed to create the survey nutrient data base, including all items used as ingredients in recipes. The 30 food components for which data are included are listed in these slides. The Nutrient Data Research Branch at HNIS is in the process of adding individual fatty acids to this data set.

Most of the data in the PDS come from the USDA Nutrient Data Base for Standard Reference, which is the computer data set corresponding to Agriculture Handbook No. 8 (AH-8). This data base is continually reviewed and updated, with revisions made available in our annual supplements to AH-8. Also, nutrient values are added as needed for nutrients not in the Standard Reference Data Base. For example, Vitamin E data are incomplete in the Standard Reference.

A new PDS code with complete nutrient profile is created for any food needed for the survey that is not in Standard Reference, like new ready-to-eat cereals and salad dressings. To derive the nutrient profile, several sources are used. Analytical data are the first choice. If they aren't available, values are imputed from other forms of the food, or estimates are derived from data for similar foods, or label nutrition information is used to calculate the nutrient amounts. A code is included with each value to indicate whether it is analytical or imputed, and imputed values are replaced with analytical values as data become available.

The PDS currently has over 3,300 food items in it. Data are expressed as the amount of each nutrient in 100 grams of the edible portion of the food.

Another data set used by the computer is the file of nutrient retention factors. This file contains the factors for calculating the retention of 18 vitamins and minerals during cooking. Contract research designed to study the retention of nutrients during cooking was the source for many factors. The file is based primarily on the HNIS "Table on Percent Retention of Nutrients in Food Preparation" but contains several more specific categories of foods and cooking methods. Because analytical data on nutrient retention are not available for all nutrients in each food category, missing factors were estimated to complete the table. Each category of food and the specific process to which it is subjected (cooking or drying) is assigned a code for computer access, designated the retention code. This slide shows some examples of retention codes and descriptions for flour.

The retention factors are percentage adjustments in the nutrients that account for the effect of cooking on the nutrient content. The cooking method, the cooking time, the presence of water, the presence of drippings (as in the case of meat and poultry), and the type of food (such as lean vs. fatty fish) all affect the amounts of vitamins and minerals retained in the final product. By applying retention factors to a recipe ingredient, the content of vitamins and minerals will be adjusted to create the final product's nutrient profile.

Retention codes are linked to retention factors, which are expressed as a percentage of the nutrient retained as related to cooking method. As an example, if flour were baked, using retention code 0301 would result in 80% thiamin retention, 90% each riboflavin and niacin retention, and 100% iron retention. During the recipe calculation, these percentages are applied to the nutrient values for flour to account for the effects of baking the flour.

These retention codes are used in the recipe file. The recipe file 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 the recipe file, each of the 6,632 survey food codes is linked to one or more PDS items through a set of recipe codes.

A number of items are needed for each recipe: Ingredient descriptions with their corresponding PDS codes, ingredient weights in grams (excluding refuse), and appropriate retention codes for the ingredients.

Each recipe must have a percentage yield - the final weight of the cooked recipe expressed as a percentage of the uncooked weight. This yield is derived by considering any moisture and/or fat change (gain or loss) that occurs in cooking, also expressed as a percentage (plus or minus) of the total weight of the uncooked recipe. For recipes with a fat gain or a fat loss during cooking, the type of fat must be specified by including the correct PDS code for it. If the food is fried, the code chosen may be the frying fat that was used. Agriculture Handbook No. 102, Food Yields Summarized by Different Stages of Preparation, is used as one of the sources for moisture and fat changes during cooking.

The recipes in the recipe file are then run through a computer program. This calculates the nutrient values per 100 grams edible portion for each survey food based on its recipe, thus creating

the survey nutrient data base. All nutrient values come from the PDS, either directly for a one-component recipe or indirectly through recipe calculations.

The recipe calculation method involves a number of steps. First, the weight in grams of each ingredient is determined; refuse is subtracted out. Agriculture Handbook 8 contains refuse information and weight-volume relationships.

Second, the nutrients in the specified weight of each ingredient are determined. Nutrient values for 100-gram amounts of ingredients are stored in the PDS.

Third, retention factors are applied to vitamin and mineral values for those ingredients being cooked. The Table of Nutrient Retention Factors contains the retention codes and factors.

Fourth, all ingredient weights are summed to determine the total uncooked weight of the recipe.

Fifth, all nutrient values of the ingredients are summed to determine the nutrient totals for the recipe.

Sixth, moisture and/or fat changes are used to adjust the total values. Moisture may be lost through evaporation or drippings, or it may be gained through absorption. The total moisture value and the total weight of the recipe are adjusted at this point. Fat may be lost through drippings or gained through absorption during frying. Fat changes affect total weight, energy, total fat, fatty acids, and sometimes cholesterol, minerals, and fat-soluble vitamins. These values are also adjusted at this step.

The last step in the recipe calculation is to convert the recipe's total nutrient values to the 100-gram basis.

So you can better understand this process of calculating a recipe, I will use, as an example, ham croquettes. This product calls for already cooked minced foods to be bound together in a white sauce, and then shaped, breaded, and deep-fat fried.

The recipe was entered into the recipe file with the information on this slide. We see eight ingredients listed with their corresponding PDS codes and gram weight amounts. Several of the ingredients are in the raw form; therefore, retentions need to be applied to account for nutrient losses during deep-frying. The amount of parsley is so small, 1.1 grams, that a retention code is not applied to it.

Lastly, we see that for this recipe (coded as 272-2008), there is a 15 percent moisture loss and 4 percent fat gain from deep-fat frying. The frying medium is designated by the PDS code 04031, household hydrogenated soybean and cottonseed shortening.

The recipe program calculates the nutrients for the specified weights of the PDS codes and applies the appropriate set of retention factors to the resulting nutrient values if a retention code has been designated. Calculations for the thiamin in milk are presented on this slide.

In order to illustrate the moisture and fat change effects on the nutrient values and total weight of the ham croquettes, I have shown the steps in the calculation procedure on this slide. The weight and nutrient values for the individual ingredients are summed. The moisture loss decreases the weight of the recipe by 99 grams (15 percent of the subtotal recipe weight of 660 grams) and, of course, of the moisture value by this same amount. The fat gain increases the weight of the recipe by 26.4 grams (4 percent of the subtotal recipe weight of 660 grams).

The total fat value increases by this same amount also. The increase of 233 calories is calculated from the calorie value for 04031, the frying shortening used, with the gain of 26.4 grams of fat. Fatty acids and Vitamin E totals would also be affected and need to be adjusted at this point.

Finally, all nutrient values are converted to the 100-gram basis for inclusion in the survey nutrient data base.

Conclusion

To summarize, the nutrient retention factor method of calculating recipes involves applying retention factors to the vitamin and mineral values of each recipe ingredient at the ready-to-cook stage. Adjustments are made for moisture and fat changes occurring during cooking, resulting in a total yield and nutrient values for the cooked item. We have been using this procedure for our survey data base for approximately 10 years, and the Nutrient Data Bank uses the same procedure for calculating recipes when they are needed for Agriculture Handbook No. 8.

We are in the process of upgrading our computer system. Although our file structures are changing, the recipe calculation method will remain the same. We will be discussing these new formats in detail tomorrow at the workshop on file formats.

SLIDE 1

DATA SET FILES

Primary Nutrient Data Set for Food Consumption Surveys (PDS)

USDA Nutrient Data Base for Standard Reference

Table of Nutrient Retention Factors

Recipe File

SLIDES 2A & 2B

FOOD COMPONENTS IN PDS

Energy	Copper
Moisture	Vitamin C
Protein	Thiamin
Fat	Riboflavin
Total Saturated Fatty Acids	Niacin
Total Monounsaturated F.A.	Vitamin B-6
Total Polyunsaturated F.A.	Folate
Carbohydrate	Vitamin B-12
Calcium	Vitamin A (in IU & RE)
Iron	Carotenes (RE)
Magnesium	Vitamin E
Phosphorus	Cholesterol
Potassium	Alcohol
Sodium	Total Dietary Fiber
Zinc	

SLIDE 3

TABLE OF NUTRIENT
RETENTION FACTORS

SLIDE 4

RETENTION CODES AND DESCRIPTIONS

0301	Flour/meal, baked
0302	Flour/meal, boiled, steamed
0304	Flour/meal, reheated
0305	Flour/meal, sautéed
0306	Flour/meal, toasted

SLIDE 5

SELECTED RETENTION FACTORS FOR

0301 - FLOUR/MEAL, BAKED

Thiamin	0.80
Riboflavin	0.90
Niacin	0.90
Iron	1.00

SLIDE 6

ITEMS IN A RECIPE

Ingredient codes and descriptions

Ingredients' gram weights

Retention codes

Moisture and/or fat change

SLIDE 7

RECIPE CALCULATION METHOD

1. Determine ingredient weights
2. Calculate nutrients in each ingredient
3. Apply retention factors
4. Sum ingredient weights
5. Sum nutrients
6. Adjust for moisture and fat differences
7. Convert nutrients to 100-gram basis

SLIDE 8

HAM CROQUETTE RECIPE INFORMATION

PDS CODE	NAME	RETENTION	GRAMS
10153	Ham, cooked		280.0
20081	Flour, all-purpose	0305	31.2
74750	Bread crumbs	0305	50.0
11297	Parsley, raw		1.1
11282	Onion, raw	3465	10.0
01077	Whole milk	2151	244.0
89630	Salt		1.4
04132	Margarine		42.3

SLIDE 9

HAM CROQUETTE RECIPE INFORMATION

Recipe code: 272-2008

Moisture change: -15%

Fat change: +4%

Fat type: 04031 Shortening

SLIDE 10

THIAMIN CALCULATION FOR MILK

$$\frac{.038 \text{ mg thiamin}/100 \text{ g milk} \times 244 \text{ g milk}}{100} = 0.093 \text{ mg thiamin}$$

.093 X 90% (retention) = 0.083 mg thiamin