Principles For Calculating Nutrient Values

Talk by

Linda P. Posati

Prepared for

Nutrient Data Bank Conference
East Lansing, Michigan

April 28-29, 1980

This morning I'd like to talk with you about the calculations involved in deriving nutrient values for use in the revision of Agriculture Handbook No. 8's food composition tables and to give you an overview of the procedures we go through to produce a revised Handbook section. The first slide is a listing of the nutrients or food constituents which we currently are trying to include. They are the proximate components, water, protein, fat, carbohydrate, and ash, the 9 vitamins shown here, up to 19 fatty acids and 18 amino acids, the percentage of refuse in the food, which is the inedible portion, 9 minerals, cholesterol, and total plant sterols. We have the capability in our nutrient data bank to code and enter over 250 nutrients. The choice of which nutrients to be included in our food tables depends on the amount of reliable data that we have for the particular commodity. We are not limited to only these nutrients on this slide. For example, we included data for total and alpha tocopherol in our section on Fats and Oils. Basically what we try to present in our food tables are nutrient values which reflect the year round, nation wide contribution of the nutrients from the foods, taking into account variations in nutrient composition.

Each food group section of the revised Handbook No. 8 is handled by a food group specialist or specialists who are familiar with the particular commodity. This slide shows the 4 basic steps which are followed in preparing our food tables using our computerized data bank system. Step 1 is, of course, to acquire the data. Our data bank consists of 3 separate files, designated as bases I, II, and III. After we obtain our

data, the food group specialist screens, evaluates, codes, and enters the original analytical data into the data base I file. The base I file for each food group is kept separate. These files can be very large. The base I dairy products file contained about 80,000 entries and the base I poultry products file held about 50,000 individual records. After we have entered all of the analytical data that we plan to use to generate the nutrient values for a commodity, we perform step 3 which is the creation of the data base II file containing the average values for like items. This generally done in 2 stages. The first consists of running a query build where we average data by any number of selection variables without creating a permanent file. The descriptive information relating to the food, such as geographic location and method of analysis, is coded when the data are originally entered and becomes the selection variables. The query also permits a final check for data entry errors. After we are satisfied as to the selection criteria, we average the data and create the permanent base II file. The last step we go through in preparing a food table is to apply weighting factors to the average nutrient values, if needed, to arrive at figures which are representative of the overall market. Foods are often weighted by various production statistics or by manufacturers' contribution of products to the market. These weighted averages appear in the base III file. The values in base III are those published in the revised Handbook 8 sections.

The first step in preparing a food table is data acquisition. No matter what the source of the nutrient data we use, it is all screened and evaluated before it is entered into the data bank system.

The reasons why the data are screened are shown on the next slide. We use only original analytical data and the averages we generate are most probable values. We do not use values from nutritional label panels mainly because the data represent minimal values rather than averages. When expressed as a % of the U.S. RDA, data are rounded to fit certain prescribed increments. For some added nutrients we will give a value based on the standard fortification level such as for vitamin D in dairy products. Any values based on fortification level will be indicated as such by footnotes and may also be differentiated by use of different style type. I've indicated on this slide that nutrient data are screened for 5 reasons--to insure accurate sample description for proper categorization, to insure adequate laboratory procedures and appropriate sampling, to put data on a uniform basis, to choose representative samples and to establish sources of nutrient variability which we need to weight the data to obtain a market average figure. This screening is especially important since the final values we derive are generated out of fairly large computer data bases.

We code all sample description information which might affect nutrient content in a food. This slide shows typical descriptive information which we would enter if it were important for a particular food. We need to code the name of the food, the part analyzed, the physical state, processing treatments, and production factors as well as other information. These codes become our selection criteria. So a major part of our screening process is in categorizing and coding the samples correctly. If this step isn't done right we would end up in a garbage in, garbage out situation.

It is not always a simple matter to code data because often we find a lack of standardization in food nomenclature and inadequate sample description. This slide shows you an example of how confusion can arise over the name of a food. In the Chesapeake Bay and on the East coast we have a fish commonly called a rock or rockfish which is actually a striped bass. There are various species of rockfish indigenous to the West coast and these are quite distinct from the rockfish common to the Bay area. Data for these 2 fish would not be combined in Handbook 8 and the striped bass shouldn't be coded as a rockfish. Our fish expert automatically codes East coast rockfish as striped bass even when they are referred to as rockfish.

The next slide shows a case of inadequate sample description. I obtained data for 2 samples identified only as parmesan cheese. Sample A is actually a grated product and sample B is a hard product. There is a difference in the nutrient content of the 2 samples due to their physical form. The grated cheese, sample A, contains 19% water while the hard cheese, sample B, contains 30% water and has a lower content of protein, fat, ash, and calcium. I would not want to combine the data for these 2 samples so I have to qualify them as to their physical form. I would have to find out from my data source exactly what the physical forms of the cheese were before I would code this type of material.

This slide shows you how important the nutrient differences can be due to the portion of a sample that is analyzed. The sample here is raw chicken meat and the parts analyzed are tissue from the breast and

tissue from the leg. The data are the mean values from the revised Poultry Products section of Handbook 8 expressed as a % of U.S. RDA for a 100 gram portion. The magnitude of the differences is the same for cooked meat. Only in the case of iron did any of the analytical values that these means are based on overlap. There are definate differences between these 2 tissues--protein differing by about 6%, zinc by 9%, riboflavin by 6%, and niacin by 25% of U.S. RDA. I cannot really use data for a sample described only as "chicken". Although I could probably infer from the nutrient data given for a sample if the tissue were light meat, dark meat, or a combination of both, and if it were with or without skin, I would screen out such data rather than risk compromising averages I plan to get for different tissues from samples adequately described.

The second reason I had mentioned earlier for screening data was to insure that the data were obtained by a reliable analytical method. This slide shows you percentages of neutral and polar lipids reported in eggs when different solvent systems were used. These figures are from 3 different published reports which were presenting fatty acid data on typical egg samples. All of the lipid in egg yolk appears to be bound to protein as lipoprotein complex. "Free" lipid can be extracted from yolk solutions with ethyl ether but a considerable portion of the phospholipid remains bound to protein with that type of solvent. A better extraction of egg lipids is obtained using a mixed solvent system such as the chloroform-methanol shown on the first line. The values shown on the second 2 lines of the slide are probably not correct--the percentages of neutral lipid being too high and phospholipid too low. I would not use fatty acid data run on lipids extracted using the second two solvents

because they would not reflect the total lipid pattern.

When screening data we always check the values for reasonableness. Occasionally we obtain data containing simple decimal errors such as shown on this slide. In this case the average ash content of Roquefort cheese was about 6% indicating the presence of a good amount of salt. We received sodium values averaging 182 mg. This figure is not consistent with an ash content of 6%. After double checking with our source of data we found that there had been, in fact, a transcription error in reporting the 182 mg figure. It should have been 1,822 mg. So we always make every effort to verify any figures that appear to be unusual.

The third reason I gave for screening data was to put it on a uniform basis. In our data bank every nutrient has a standard unit. This slide shows you results of a query for copper in beef frankfurters, which we ran to see if any data had been entered in a nonstandard unit. The unit for copper is mcg/100 g of food. Here we see an average value of 2.299 mcg of copper per 100 gram of food. The frequency is the number of copper values entered--here 116 samples. Notice that the standard deviation is gigantic compared to the mean and that values range from a low of 0.062 mcg to a high of 135 mcg. The apparent low value is erroneous and actually was expressed in mg/100 g food. We have unit conversion built into the system and, as we suspected in this case, the unit conversion field was not filled when part of the data were entered. We would next correct the original entries. Putting data on a uniform basis is usually a simple matter but if it is not done one's results will be havoc as in this case.

Quite frequently data are expressed on bases other than g/100 g

food as shown on this slide. Minerals might be expressed as % of the ash. Any nutrient might be given on a dry weight basis. Cholesterol is sometimes expressed as mg/100 g of fat. Beta-sitosterol and alpha-tocopherol might be given as % of total sterols or total tocopherols, respectively. Amino acids are often reported on a per 100 g of protein or on a 16 g of nitrogen basis. Fatty acids are frequently given as weight % of their methyl esters. The amino acid and fatty acid data are usually not handled on the basis of 100 grams of food. The other data shown here have to be converted to the 100 g food basis before entry into the system. Actually the conversion is done within the system but we have to know the ash, solids, and/or fat content of the analyzed sample on a wet weight basis or know the total sterol or total tocopherol content of the food in order to effect the conversion. Obviously we don't always have the information needed to carry out the conversions. In that case the data are put aside to be used only if we find that we are completely missing data for a nutrient on a 100 gram food basis for a particular product. Data on these other bases, like % of ash, then might be used to calculate a figure for a missing nutrient.

The last example I'll give you of how we screen data is of the exclusion of atypical samples. This slide shows you the changes in the fatty acids of egg lipids of chickens fed experimental rations. The major changes are in the proportions of oleic and linoleic acids and in myristic acid when coconut oil is fed. There is no pattern on this slide that is typical of the lipids in market eggs. Even the control lowfat ration pattern is atypical. Because all of these fatty acid patterns are modified, none of this data could be used. The published

literature contains many studies of this type examining production parameters and one has to be careful in choosing data from such studies to make sure that they are representative of products actually on the market.

After we have acquired, screened, and entered our data for a food group we proceed to average the values. A number of factors are used in our nutrient calculations as shown on the next slide. These are calorie conversion factors, nitrogen conversion factors, fatty acid conversion factors, and refuse factors, which we use in calculating data for food on the pound as purchased basis.

The calorie conversion factors are used to obtain energy values which represent the energy available from the food. They are simply the gross energy of the food minus the losses in urine and feces. We have a set of 48 specific factors for use with different foods and food groups. We don't use the general factors of 4, 9, 4 for calculating calories for the individual foods. The nitrogen conversion factors are used for calculating protein content of food. Protein content is not determined directly. Rather, the nitrogen content is measured and converted to protein by multiplication by these factors. The specific factors that we use are the Jones' factors. They are equivalent to 100 divided by the % of nitrogen in the protein of proteins of the food products. We always list in the table the specific factor we used for each food to calculate protein.

When we handle amino acid data in our system we avoid using nitrogen conversion factors until after we have averaged the data. As I said before amino acids are often expressed on bases other than gram or mg

per 100 g of food. This slide shows you typical data bases on which lysine in nonfat dry milk might be expressed. The same set of data is presented in 4 commonly used ways. The lysine content could be expressed first as 8.49 g lysine per 100 g of protein, the protein having been determined by multiplying total nitrogen by the milk nitrogen conversion factor of 6.38. The same data could be given as 8.67 g lysine per 16 g of nitrogen. It could also be on the basis of 100 g of food as 2.925 g, if the protein content of the milk were 34.45%. Alternatively the lysine could be presented as 7.44 residues per 100 g of protein. The lysine residue is the weight of lysine less the weight of 1 molecule of water. When we enter amino acid data into the data bank we convert it to a gram per gram of nitrogen basis. For the first case on the slide we take the 100 g of protein and divide it by 6.38 to get its nitrogen content which is 15.67 g. The lysine value is then divided by 15.67 g of nitrogen to express it as the amount in 1 g of nitrogen. In the second case the lysine value of 8.67 is simply divided by 16. To convert data in the third example we have to know the protein content and what nitrogen factor was used to generate it. Usually this information is given. After these conversions are carried out, all the original data reduce to 0.542 g lysine per 1 gram of nitrogen. Data for all amino acids are averaged on this nitrogen basis, regardless of how the data were originally reported.

After averaging data on this basis, the results are converted to amounts in 100 g food as shown on this slide. These are data for cheddar cheese. The mean nitrogen content was found to be 3.903% for 42 samples. This nitrogen content corresponds to 24.90% protein. The average of data for tryptophan was 0.082 g TRYP/1 g of nitrogen based on 10 analyses.

This tryptophan value is multiplied by 3.903 g nitrogen/100 g food to obtain 0.320 g TRYP per 100 g food. Our food tables list the protein content and always specify the nitrogen factor used to calculate protein so that amino acid values presented as g/100 g food can be converted back to the nitrogen basis on which they were originally summarized or to any other basis.

The other set of data that are not always handled on the g/100 g food basis in our data bank are for fatty acids. All of the fatty acid data we use are obtained by gas liquid chromatography. Most that we have up to now was run on packed columns and not capillary columns, and most of these data were reported as weight % of fatty acid methyl esters. We currently have 2 options in the data bank for handling fatty acid data. They can be entered and averaged as g/100 g food or entered and averaged as weight % methyl esters. The next slide is an example of how we average methyl ester or weight % data. In many instances the numbers of fatty acids reported by different sources for the same fat are not the same. For milkfat, butyric (C4) and caproic (C6) are often not reported because they are volatile and water soluble. However, they represent about 6% of the total fatty acids. On the first sample of milkfat shown on the slide butyric and caproic acids were included in the analysis. Probably 12 to 15 acids were reported, all adding to 100%, and each acid being reported as a % of the total acids analyzed based on the total chromatogram peak area. On the second sample, record 2, butyric acid was not included in the analysis and the other acids are expressed as weight % of the fatty acids which were detected. On record 3 both butyric and caproic are missing and are not included in the sum of all the fatty acids upon which the values for each other

acid are based. Because these data are not actually on the same basis, a positive error in summation results when a straight average or arithmetic mean of each fatty acid reported is taken. The fatty acids shown in records 2 and 3 are overestimated by different amounts relative to record 1.

In order to put these data on the same basis while using all observed values, we run the entire data set through a normalizing program developed by our statistical staff. We use the initial estimation of the percentages of each fatty acid. These estimates must sum to 100%. The percentages are normalized so that the total obtained equals the totals of the estimated percentages that were analyzed in the experiment. The normalized percentages are averaged. A new iteration is then carried out using these obtained values as new estimates of missing values. Iteration is continued until the percentage deviation between two consecutive iterations is within a certain tolerance limit and the values converge. The values obtained by going through this procedure are shown on the last line of the slide.

After we have averaged fatty acid data as weight % of their methyl esters, we convert these averages to grams of fatty acid per 100 grams of lipid. We do this using the fatty acid conversion factors previously mentioned. This slide demonstrates the derivation of the fatty acid conversion factor for egg lipid. A conversion factor could be obtained by direct determination of the fatty acid content of the total lipid. Alternatively, the individual lipid classes and fatty acid content of these lipid fractions could be quantified and used to calculate an average value applicable to the total lipid. This is what was done to obtain a factor for egg lipid shown here. Compositional studies show that egg lipid consists of 65% triglyceride, 24% lecithin, and 6%

cephalin. The rest of the lipid is mainly cholesterol. GLC analysis of the fatty acids in these 3 lipid fractions shows that the average molecular weights of their fatty acids correspond to acids of carbon chain lengths of 17, 17, and 18 carbons, respectively. Fatty acids of these chain lengths would contribute 95.6, 70.8, and 75.6% of the weight of the 3 fractions. The right column shows the grams of fatty acids in 1 gram of egg lipid contributed by the 3 fractions. The sum of these 3 figures is 0.83, which is the conversion factor. One hundred grams of egg lipid contains 83 g of fatty acids. Weight % methyl ester data are multiplied by the conversion factor and by the total fat content to obtain fatty acid content per 100 g of food.

The fourth type of conversion factor that we use in nutrient calculations is the refuse factor. This slide shows the use of the refuse factor to calculate data for protein for 1 egg and for 1 pound of eggs as purchased. Refuse for eggs represents the shell. In the revised Handbook sections we give the nutrient data for an edible portion equal to 100 g of food, and also for the edible portion of 1 or 2 market units and in one pound as purchased. In this example, the refuse content is 12%; therefore 88% of the egg with shell is edible. The average egg protein content was 12.14% of edible portion. The as purchased weight of 1 egg is 57 g with shell. 88% of this is the edible weight which is 50 g. Protein in the edible portion of 1 egg is 6.07 g. This 6 g of protein would be shown in Handbook 456 with the AP weight of 57 g. In HG-72 and the revised handbook sections the 6 g is shown with the EP weight of 50 g. To calculate the protein of 1 lb of egg, as purchased, we take the as purchased with shell weight of 1 lb and multiply it by

88% to obtain the edible weight in 1 lb, equal to 399.2 g. The amount of protein in 1 lb of egg, AP, is 48.46 grams.

For those nutrient values that are in Handbook 8 that are an average of raw analytical data contained in data base I, we give in the tables the standard error and the number of samples on which the averages are based. If you have looked at the tables of the revised Handbook sections you'll notice that sometimes the standard errors are not included for some nutrient values. These nutrient values substitute for missing analytical data. They are obtained as shown on this slide. All missing nutrient values that are calculated are indirectly based on analytical data. If we do not have actual analytical data for some nutrient in a specific food, we can calculate a nutrient value from analytical and physical composition data for foods such as cuts of meat, which consist of different tissues. We can also calculate nutrient values from analytical data for similar or closely related forms of the food. If we need data for cooked foods, it may be obtained from data for the raw food by the application of yield and retention factors. We may also supply nutrient values by calculations using recipes. I'll give you some examples of each of these types of calculations. Another way to calculate data for a food is by using certain weighting factors. This was done in the poultry section where data were calculated for what I'd call an "all classes" turkey based on the percentages contributed to the market by 3 classes of turkey--fryer-roasters, young hens, and young toms. An "all classses" turkey does not exist but such nutrient data are the most appropriate figures to use to calculate nutrient contribution of turkey to the food supply. As a last resort to supply nutrient values, we occasionally impute a figure based on data for a different food. An example of this

would be in using data for duck and applying it to goose. Values imputed in this way are always footnoted as imputed figures.

This slide shows an example of calculated values based on physical composition data. When preparing the revised section on poultry products, I found that I did not have analytical data for cholesterol on a raw chicken thigh with skin, which was an item to be included in the book. However, I did have analytical data for the cholesterol content of the component tissues of this cut of chicken, that is, the raw thigh meat, raw skin, and the separable fat. I also had extensive data on the percentages of these tissues in this particular chicken part. The slide shows the average cholesterol content in mg/100 g, edible portion, of the 3 tissues. The right hand column is the weight percent contributed by each tissue to the edible portion of this chicken part. I obtain a calculated value for cholesterol in this thigh by multiplying the cholesterol content of each tissue by the weight % of each tissue and summing the results.

This slide shows you the same type of calculation done in a slightly different fashion. It is for oleic acid in the flesh and skin of a raw, whole chicken, exclusive of the giblets and neck. Most of the fatty acid data published for poultry were run on separated tissues, breast muscle, which I used for light meat, thigh muscle, which I used for dark meat, skin, and fat. In the first column I've listed the average of our data for oleic acid on a g/100 g fat basis for the 4 tissues making up the whole chicken. The number of analyses on which these averages are based are shown in parens. In the second column I've listed the average % fat in each tissue and the number of samples on which these are based. The right column, as in the last slide, is the

weight % contributed by each tissue to the edible portion of the whole bird. I also had an average value for the fat content of the whole chicken which was, by analysis, 15.055% based on 82 samples. Using the sum of the product of the fat contents of each tissue and the weight percent of each tissue, I would calculate a fat content of 15.538% from these data. To get the oleic acid content of the whole chicken, I simply take the sum of the products of oleic acid times % fat times the weight % of tissue for all four tissues and then adjust the value by the ratio of the analyzed versus calculated fat content. Much of the fatty acid and amino acid data in the poultry section are handled this way. It's done by program which creates the file of calculated data which are inserted into data base II.

This slide shows you a sample calculation of values based on closely related forms of food. The specific nutrient contributions of each of different kinds of milk depend primarily upon the concentration of milkfat and milk solids not fat (MSNF on the slide) in the product. Here I want to calculate the calcium content of 3 1% fat lowfat milks: the plain milk, the milk containing added milk solids not fat, and what was called a protein fortified milk, which contained over 10% added milk solids not fat. I had a considerable amount of analytical data on the milk solids not fat content of these 3 types of lowfat milk but a relatively small amount of analytical data on their calcium content. However, a large number of calcium values were available for whole milk, where the milk solids not fat content was known. I used the calcium content of whole milk, 13.88 mg Ca/g MSNF, to calculate the calcium content of these lowfat milks based on their known MSNF content simply by multiplying that level of calcium/g MSNF in whole milk by the percentage of MSNF in the 3 products.

Another type of calculation based on closely related forms of food is this shown for B_6 in raw turkey dark meat without skin. For this particular vitamin the only dark meat data available were analyses of B_6 in raw thigh tissue from 18 turkey hens. The mean values were 0.351 mg B_6/100 g wet thigh tissue. In the Poultry Products Handbook section I was including nutrient data for 3 classes of turkeys: fryer-roasters, young hens, and young toms. The nutrient data for these turkeys were fairly extensive for proximate components, minerals, thiamin, riboflavin, and niacin. For B_6, however, I would have had missing values for dark meat, which includes thigh, drumstick, and back meat, if I did not use these particular data shown on the slide. The average water, fat, and moisture free-fat free solids of the dark meat without skin, as analyzed, of the 3 turkey classes are shown on the slide. Some differences are apparent in these data. The MFFS are higher than that for the thigh meat in the 18 hens that was analyzed for B_6 content. I calculated the B_6 content for the dark meat of these 3 turkey types by multiplying the 0.0173 mg B_6/g MFFS by the percentage of MFFS in the respective tissues of the 3 turkey types. This represents only an adjustment for chemically determined moisture and fat.

The next slide shows an example of how nutrient values can be calculated for cooked foods. Here I want to determine the thiamin content in light meat without skin for a stewing chicken after it has been cooked by stewing. The analytical data available to me are the thiamin content of the raw tissue, the % retention of thiamin in light meat upon stewing based on studies with broiler-fryer chickens, and the % yield of light meat of stewers upon cooking by this procedure. The thiamin content of

the cooked meat is estimated by multiplying the thiamin content of the raw meat, 0.132 mg/100 g, by the retention, and dividing the product by the yield to express the data on the 100 g of cooked food basis.

In addition to determining nutrient values in foods, we compile data on cooking yields and the retention of nutrients on cooking for use in the type of calculation you just saw. This slide shows an example of the determination of a yield factor for chicken breast using one particular sample from the study on poultry that we had done at VPI. In this study the raw and cooked samples were from the same chickens and were paired. The breast from 1 chicken was split into left and right halves. The left raw breast was weighed in at 194 g and then separated into component parts of meat, skin, fat, and bone, each of which was weighed. The right breast was also weighed raw at 192 g. It was then roasted, weighed after cooking at 134 g, and then separated into meat, skin, and bone. In the right hand column I've adjusted the cooked weights by the ratio of the raw weights of the left to right breast to eliminate discrepancies due to cutting. The yields are calculated using the data in the left and right hand columns. The cooked yield of the entire breast or part with bone is 70%. The yield of cooked meat from raw meat is the weight of cooked meat, 98g divided by the weight of raw meat, 132g, and equals 74%. The yield of the total edible portion of the breast is the sum of the weights of cooked meat and skin divided by the sum of the weights of raw meat, skin, and separable fat and is 72%. The different tissues, including, bone, lose different amounts of weight on cooking.

In the next slide I have calculated retention factors for the proximate components of this whole chicken breast. The raw weight of 155g is the sum of the weights of raw meat, skin, and fat. The roasted weight, 112g, is the sum of the weights of the cooked meat and skin - 112 divided by 155 represents the cooked yield of 72%. Below the weights are the analytical data for the raw and roasted parts. The % retention for, say water, is the amount of water in the cooked breast, 62.89%, multiplied by the 72% yield factor, and divided by the % of water in the raw breast, 70.01%. The % retentions are 65% for water, 92% for protein, 74% for fat, and 72% for ash. Going to the second sets of lines on the slide, I have put down the raw data again. When I multiply them by the retention figures, I get the grams of nutrients in 72g of cooked breast. The differences between these figures and the data in the left hand column represent the changes occuring in the sample on cooking. A sample of chicken breast weighing 100 grams would lose almost 25 grams of water, 1.7g of protein into the drippings, 1.9g of fat, and 0.27g of ash to drippings. The solids lost on cooking, that is, the protein, fat, and ash, represent 14% of the total weight loss of 28g. If I calculated a retention for protein for this sample based on total solids it would be 103%, as shown on the last line. It would be higher than the actual 92% retention figure because the weight lost on cooking was not all due to water. The purpose of the retention factors is to allow us to calculate nutrient data for cooked foods using nutrient data for raw foods. If I had this particular raw sample containing 22% protein and tried to calculate the protein in the cooked sample using a 103% retention based on total solids, I would calculate a figure of 31.5% protein in the cooked sample, which, by analysis, has only 28% protein.

For our food composition tables and for other purposes we calculate nutrient values using recipes. This slide shows a typical recipe calculation for fried flounder fillet. I've taken the recipe ingredients and listed their edible portion weight in the first column. These weights would be taken from AH-456. I' ve then taken nutrient values from either the 63 Handbook or revised sections and listed their amount for the particular weight shown. These are nutrient values for the raw ingredients. I've applied retention factors to the raw values for thiamin, which is heat labile, in the right hand column. For the fish on the top line I've multiplied the raw thiamin value by a 75% retention factor. These factors are those contained in AH 62-13. Under the first solid line is listed the sum of all the nutrient values. On cooking this fillet mixture looses 20% water. I subtract the water from both the weight and water columns. For this recipe there was a 10% fat uptake in final product. 86 g of fat are added to the weight and fat columns, and the calories from absorbed fat are also added. For this mixture, the water loss and fat absorption on frying were calculated from analytical data for a cooked sample which was prepared using this particular recipe. The sum of all these data are the nutrients in 944g of product. Since we generally express our data on the per 100g food basis, I've calculated it to that basis on the last line.

We don't always calculate a recipe by using raw data and applying yield and retention factors to these data. This last slide shows a case where the recipe ingredients are used to obtain the proportions of cooked ingredients they would yield. These proportions would then be applied to analytical values for the cooked ingredients, as contained in Handbook 8, to calculate the recipe. The raw ingredients

of this recipe are rice, peas, and eggs, all of which are to be boiled and mixed together. I take the raw edible weight of the 3 ingredients and multiply them by the cooked yield of each ingredient to get the cooked weight contributed by each raw ingredient. I then express the cooked weights as a percent of total cooked weight and would calculate this recipe by applying the figures in the right hand column to nutrient data on a 100g basis for the 3 cooked foods, thus avoiding having to apply retention factors to the data for the raw food.

I hope the preceding discussion and examples of the general steps we go through in preparing our food tables from screening of data, application of factors in calculating nutrient values, and samples of typical calculations we perform have given you a better insight into the operations of our nutrient data bank system.

VALUES IN REVISED HANDBOOK 8

- Proximate
- Vitamins
  - Ascorbic acid
  - Thiamin
  - Riboflavin
  - Niacin
  - Pantothenic acid
  - B_6
  - Folacin
  - B_{12}
  - A
- Fatty acids
- Amino acids
- Refuse
- Minerals
  - Calcium
  - Iron
  - Magnesium
  - Potassium
  - Phosphorus
  - Sodium
  - Zinc
  - Copper
  - Manganese
- Cholesterol
- Phytosterols

CFEI 1320-80

STEPS IN PREPARING FOOD TABLES

1. Acquire data

2. Screen, evaluate, enter data
   (create Base I file)

3. Query by selection variables;
   average like items (create Base II file)

4. Apply weighting factors, eg., production
   statistics (create Base III file)

CFEI 1321-80

WHY NUTRIENT DATA ARE SCREENED

1. To insure accurate sample description for proper categorization

2. To insure adequate laboratory procedures and appropriate sampling

3. To put data on uniform basis

4. To select data representative of market samples, ie., exclude atypical samples

5. To establish sources of variation in nutrient composition

CFEI 1325-80

SAMPLE DESCRIPTION NEEDS

1. Accurate nomenclature
2. Portion or cut analyzed
3. Physical state
4. Processing or cooking treatments
5. Production factors - geographic area, grade, maturity, storage, season

CFSI 1326-80

NOMENCLATURE CONFUSION

AREA	COMMON NAME	ACTUAL SPECIES	SCIENTIFIC NAME
Chesapeake Bay	Rock or Rockfish	Striped Bass	Morone saxatilis
West Coast	Rockfish	Rockfish	Sebastodes spp.

CFEI 1327-80

INADEQUATE SAMPLE DESCRIPTION

Sample ID: Parmesan cheese
Physical Form: Grated or hard???

Nutrient (%)	Sample A	Sample B
Water	19.40	30.90
Protein	39.03	34.95
Fat	29.90	23.40
Ash	7.53	5.83
Calcium	1.33	1.27

CFEI 1328-80

NUTRIENT DIFFERENCES BETWEEN TISSUES

Nutrient (% U.S. RDA/100g)	Chicken, raw	
	Breast meat	Leg meat
Protein	51.3	44.7
Iron	4.0	5.7
Zinc	5.3	13.7
Riboflavin	5.4	11.4
Niacin	56.0	30.3

CFEI 1329-80

SOLVENT
Effect on Extraction of Egg Lipids

SOLVENT	NEUTRAL LIPID (GLYCERIDES & STEROLS)	POLAR LIPID (PHOSPHOLIPIDS)
	% OF TOTAL LIPID	
CHLOROFORM-METHANOL (2:1)	71	28
CHLOROFORM	85	14
PETROLEUM ETHER	90	10

QUESTIONABLE DATA

	Roquefort Cheese
Ash content	6.44%
Sodium - reported	182 mg
Sodium - verified	1,822 mg

CFEI 1330-80

NON-STANDARD UNITS

Base II Query for Beef Franks

Unit	MCG
Nutrient	Copper
Average	2.299
Frequency	116
Stnd. deviation	13.134
Low	.062
High	135.000

CFEI 1332-80

DATA BASES OTHER THAN G/100G FOOD

Data	Base
Minerals	As % of ash
All nutrients	On dry weight basis
Cholesterol	As % of fat
Beta-sitosterol	As % of total sterol
Alpha-Tocopherol	As % of total tocopherol
Amino acids	Per 100g protein or 16g N
Fatty acids	As weight % of methyl esters

FATTY ACIDS OF EGG LIPID

Of Chickens Fed Experimental Rations

FATTY ACID (%)	LOW FAT	OILS			
		COCONUT	CORN	OLIVE	SAFFLOWER
MYRISTIC (14:0)	1.0	5.9	0.3	0.2	0.2
PALMITIC (16:0)	25.0	25.8	23.5	22.2	23.6
PALMITOLEIC (16:1)	4.7	5.8	2.8	3.9	2.4
STEARIC (18:0)	8.5	8.4	6.8	4.9	8.6
OLEIC (18:1)	55.3	45.9	42.7	58.1	37.2
LINOLEIC (18:2)	4.8	4.9	21.1	9.7	27.0

Adapted from R.D. Pankey and W.J. Stadelman. 1969. J. Food Sci. 34:312.

FACTORS USED IN NUTRIENT CALCULATIONS

1. Calorie conversion factors
2. Nitrogen conversion factors
3. Fatty acid conversion factors
4. Refuse factors for as purchased values

CFEI 1334-80

LYSINE CONTENT OF NONFAT DRY MILK

	DATA BASES	CONVERSION TO G/G N BASIS
1.	8.49 g LYS/100 g protein (N X 6.38)	100 g protein/6.38 = 15.67 g N 8.49 g LYS/15.67 g N = 0.542 g/g N
2.	8.67 g LYS/16 g nitrogen	8.67 g LYS/16 g N = 0.542 g/g N
3.	2.925 g LYS/100 g food-protein = 34.45% (N X = 6.38)	34.45 g protein/6.38 = 5.40 g N 2.925 g LYS/5.40 g N = 0.542 g/g N
4.	7.44 residues LYS/100 g protein (N X 6.38)	100 g protein/6.38 = 15.67 g N 7.44 (146.2/128.2)/15.67 = 0.542 g/g N

CFEI 1340-80

CONVERSION OF MEAN AMINO ACID VALUES TO G/100 G FOOD FOR CHEDDAR CHEESE

Nutrient	Mean	N
Nitrogen	3.903%	42
Protein (N X 6.38)	24.90%	42
Tryptophan	0.082 g/g N	10

0.082 g TRYP/G N X 3.903 g N/100 g food
= 0.320 g TRYP/100 g food

CFEI 1341-80

AVERAGING FATTY ACID DATA

Milkfat

	Fatty acids (wt%)				
	4:0	6:0	8:0	>8:0	Sum
Record 1	3.8	2.3	1.3	92.6	100
Record 2		2.4	1.7	95.9	100
Record 3			0.8	99.2	100
n	1	2	3	3	
Arithmetic mean	3.8	2.4	1.3	95.9	103.4
Normalized average	3.7	2.3	1.2	92.7	99.9

CFEI 1343-80

EGG LIPID

Derivation of Conversion Factor (F)

LIPID FRACTION	WT. % OF TOTAL LIPID	g. FATTY ACID/ g. LIPID FRACTION	g. FATTY ACID/ g. LIPID
TRIGLYCERIDE	65	0.956	0.62
LECITHIN	24	0.708	0.17
CEPHALIN	6	0.756	0.04

$$F = (65 \times 0.956) + (24 \times 0.708) + (6 \times 0.756)$$

$$F = 0.62 + 0.17 + 0.04$$

$$F = 0.83$$

REFUSE FACTORS

Chicken egg: Refuse = 12% (shell)

EP = Edible portion
AP = As purchased portion
Protein = 12.14 g/100 g, EP

Amount of protein in EP of...

	1 egg	1 LB eggs, AP
AP wt.	57 g with shell	453.6 g with shell
EP wt.	50 g (57 x .88)	399.2 g (453.6 x .88)
Protein	6.07 g (12.14 x .50)	48.46 g (12.14 x 3.992)

MISSING NUTRIENT VALUES

1. Calculated:
   a. From analytical and physical composition data
   b. From analytical data for similar or closely related forms of the food
   c. By application of retention and yield data for raw foods to obtain cooked values
   d. From recipes
   e. By use of some types of weighting factors
2. Imputed: Based on data for a different food

CFEI 1445-80

CALCULATED VALUES BASED ON PHYSICAL COMPOSTION

Cholesterol in chicken thigh with skin, raw

Tissue, raw	Cholesterol mg/100 g	Weight % of tissue (EP)
Thigh meat	.83	72.99
Skin	109	16.14
Separable fat	58	10.87

Cholesterol in thigh with skin = (83 x .7299) + (109 x .1614) + (58 x .1087) = 84 mg/100 g

CFEI 1446-80

CALCULATED VALUES BASED ON PHYSICAL COMPOSITION

C18:1 in chicken flesh and skin, raw

Tissue, raw	C18:1 g/100 g fat	Fat %	Weight % of tissue (EP)
Light meat	20.50 (27)*	1.652 (26)	31.95 (256)
Dark meat	25.84 (24)	4.311 (25)	39.49 (256)
Skin	34.22 (33)	32.345 (36)	17.09 (256)
Separable fat	37.22 (70)	67.949 (40)	11.45 (256)

% fat in flesh and skin:
by analysis 15.055 (82)
calculated 15.538

C18:1 = [(20.50 x .01652 x .3195) + (25.84 x .04311 x .3949)
+ (34.22 x .32345 x .1709) + (37.22 x .67949 x .1145)]
x (15.055/15.538) = 5.17 g/100 g food

---

* Numbers in ( ) = numbers of samples

CFEI 1447-80

CALCULATED VALUES BASED ON CLOSELY RELATED FORMS OF FOOD

Calcium in 1% fat lowfat milks

Base = whole milk: 8.57% MSNF; 13.88 mg Ca/g MSNF

Food	MSNF %	Calcium mg/100 g
1% fat milk	8.86	123 (13.88 x 8.86)
1% fat milk with added MSNF	9.20	128 (13.88 x 9.20)
1% fat milk with >10% added MSNF	10.23	142 (13.88 x 10.23)

CFEI 1448-80

CALCULATED VALUES BASED ON CLOSELY RELATED FORMS OF FOODS

B_6 in raw turkey dark meat without skin

Base: B_6 in raw thigh meat of 18 young hens
0.351 mg B_6/100g wet tissue
20.22 g moisture free-fat free solids
0.0173 mg B_6/g MFFS

Turkey-class	Water %	Fat %	MFFS %	B_6* mg/100 g
Fryer-roaster	76.22	2.67	21.34	0.37
Young hens	74.03	4.88	21.02	0.36
Young toms	74.70	4.11	20.97	0.36

*B_6 = 0.0173 x MFFS of tissue

CALCULATED VALUES FOR COOKED FOODS

Thiamin in light meat w/o skin of stewing chicken

Analytical data:

Thiamin in raw meat	=	0.132 mg/100 g
Thiamin retention	=	51%
Yield of cooked meat	=	72%

Thiamin in cooked meat:

$$\frac{0.132 \times .51}{.72} = 0.094 \text{ mg/100 g}$$

CFEI 1353-80

DETERMINATION OF COOKING YIELDS FOR CHICKEN BREAST

	Left Breast	Right Breast		
	Raw Wt	Raw Wt	Roasted Wt	
	g	g	g	g X 194/192
Part	194	192	134	135
Meat	132		97	98
Skin	17		14	14
Fat	6		–	–
Bone	37		21	21

Part yield = (135 x 100)/194 = 70%

Meat yield = (98 x 100)/132 = 74%

Meat + skin yield = [(98 + 14) x 100] /(132 + 17 + 6) = 72%

CFEI 1352-80

CHANGE IN NUTRIENTS IN CHICKEN BREAST MEAT AND SKIN UPON ROASTING

	Raw	Roasted	% Retention
Weight g	155	112	
Water %	70.01	62.89	64.9
Protein %	22.06	28.12	92.1
Fat %	7.28	7.45	73.9
Ash %	.99	.99	72.3

	Raw g/100g		Retention		Cooked g/72g	Loss or gain g
Water	70.01	x	.649	=	45.44	- 24.57
Protein	22.06	x	.921	=	20.32	- 1.74
Fat	7.28	x	.739	=	5.38	- 1.90
Ash	.99	x	.723	=	.72	- .27
Sum	100.34				71.86	28.48

Solids represent 14% of the weight lost
Protein Retention based on solids = 103%

CFEI 1351-80

CALCULATED VALUES BASED ON RECIPES

Fried Flounder Fillet

Recipe	Ep Wt g	H_2O g	Cal	Pro g	Fat g	Cho g	Bl
2-lb boneless fillet	907.2	737.6	717	151.5	7.3	0	.454 (X .75)
1 egg	50	37.3	79	6.1	5.6	.6	.044 (X .85)
1 tbsp milk	15.25	13.4	9	.5	.5	.7	.006 (X .90)
1 c bread crumbs	100	6.5	392	12.6	4.6	73.4	.350 (X .80)
Sum	1,072	794.8	1,197	170.7	18.0	74.7	.662
20% water loss	- 214	- 214					
	858	580.8					
10% fat uptake	+ 86		+ 760		+ 86		
Sum	944	580.8	1,957	170.7	104.0	74.7	.662
Per 100g	100	61.5	207	18.1	11.0	7.9	.07

CFEI 1357-80

CALCULATIONS BASED ON RECIPES

Ingredients	Cooking method	Raw wt EP	Cooked yield	Cooked Wt	Wt % EP
		g	%	g	
2 c rice, raw	boil	370*	308**	1,140	78.6
8 oz frozen peas	boil	227	93**	211	14.5
2 eggs	boil	100*	100	100*	6.9

* From AH-456, 1975.
** From AH-102, 1975.

CFEI 1339-80