# RECIPE CALCULATIONS: WHERE DO WE STAND?

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The development of computerized nutrient data bases has facilitated recipe analysis with respect to calculation of nutrient values, portion sizes and yields. However, the use of computers has not resolved questions concerning which procedures are best for deriving nutrient values. In fact, software makes it possible to consider a number of alternative procedures for calculating nutrient values.

Although there are varying ways to generate yield data for various stages of recipe preparation, there are basically two procedures employed to determine the nutrient value of a cooked recipe: adjusting values of raw (or unprocessed) ingredients, or using analyzed values for cooked ingredients. Simply stated, the latter, involves summing the nutrient values of cooked ingredients, and adjusting the yield to derive the edible portion sizes and nutrient values. To use values for uncooked ingredients is usually inappropriate when considering cooked foods unless nutrient retention factors are applied. The "nutrient retention method", (NRM) involves the application of micronutrient retention factors to uncooked ingredients (at the ready-to-cook yield stage), and subsequently adjusting for fat and moisture changes to derive yields and nutrient values for the cooked product. More detailed descriptions of these procedures have been provided at prior Nutrient Data Bank Conferences (1,2).

Use of the nutrient retention method (NRM) has been quite limited. The method was refined and applied to development of the recipe data base for the new National Food Consumption Survey (3), and a modified version was developed for testing in school food service settings (4). While these applications reinforce the viability and legitimacy of this method, use remains limited outside the USDA. The procedure has not been integrated into commercial nutrient analysis software, and use by other institutionally-based data banks is also limited. Given the potential value of the NRM, this bears further examination to assess factors which may be hindering broader acceptance.

**Use of cooked ingredient values to calculate nutrient values of a recipe.**

When all the ingredients in a recipe are adequately described and quantified, using values for cooked ingredients is preferable to use of unadjusted raw ingredient values or analyzed values for an entire recipe of comparable make-up. While the procedures for calculating such nutrient values are fairly straightforward, the method has several limitations. Deriving yields can be difficult using cooked food values, particularly when the ingredients go through several stages of preparation. There may be waste or discard in the preparation stage (deriving the "ready-to-cook" yield from the "as-purchased" weight). During cooking, gains and losses arise from fat and moisture changes. After cooking, more discard may be needed to derive the final edible yield. While ingredients used in the recipe of interest may be in a raw or uncooked stage of preparation, the published data for cooked items are usually equivalent to the edible cooked portion (i.e., "as served" stage), wherein waste, fat and moisture changes are factored into a single value. In order to derive the pre-cooked weights of these ingredients, the types and amounts of waste and the cooking methods must be adequately described in the food composition tables or in the data base. If these are comparable to the processing steps used for the recipe being calculated, then published values for the cooked ingredients used would be acceptable.

Frequently, insufficient detail is provided with computerized nutrient data bases to describe such preparation factors. Newer food composition tables provide more detail about preparation and yields than do the earlier tables, but many data bases don't include such descriptions in their programs or manuals. Even when this information is available, it is tedious to calculate.

When preparation and cooking procedures differ from those of foods being referenced, values may not be comparable. This limitation applies not only to waste factors, but also to cooking methods, and even to cooking time and temperature. There can be considerable variation in food preparation methods, but data that takes this into account is not always available. For many foods and complex dishes, nutrient values for the cooked item are supplied for only one or two methods of preparation. Furthermore, most nutrient data covers foods cooked individually. This makes it easier to locate values for most ingredients, but many recipes combine ingredients before cooking, as is done with casseroles and other mixed dishes. Such combinations may affect nutrient retention differently than if ingredients are cooked separately. For example, vitamin and mineral retention may be affected by differences in pH. Similarly, the retention of micronutrients in boiled vegetables will differ if the water is saved, as with soups. In this instance, minerals levels may be higher, but some vitamin levels will be lower due to longer cooking time compared to boiling.

In some instances, cooked ingredients listed in food composition tables (and data bases) have been prepared with unspecified quantities of condiments, fat, and other items which contribute to nutrient levels. This is particularly a problem for breaded or fried foods, where the amount of fat uptake and the type and amount of coating are often inadequately described. Sodium may also be added in unspecified quantities, although this is less frequently found in updated reference sources.

Finally, cooked values are not available for many commonly used ingredients. Dairy products, such as milk and cheese, are used in many recipes, yet data are supplied only for the uncooked product. In these instances, it is necessary to use values for the uncooked items when using this procedure.

In summary, using cooked ingredients to calculate recipes will be most valid when all ingredients are described and quantifiable; when ingredient yields are known and match those of the items selected from the data base; when preparation methods are similar; and when cooked values are available for all ingredients. In such instances, this procedure can certainly be easier than adjusting uncooked values, and probably as accurate. Conversely, when preparation or processing methods don't match those used for comparable items in a data base, or necessary information to determine this is unavailable, less reliance should be placed on the use of cooked ingredients. But is the NRM a viable alternative procedure?

**Using the nutrient retention method (NRM).**

The NRM uses ingredients in the "as-purchased" or "ready-to-cook" stages. While the quantities must be specified, there are often problems with converting volumes to weights, with standardizing unit values for foods that vary in size (eg., produce), and with matching waste factors to those of foods listed in the data base. These are not resolved by using the NRM. But it is easier to work forward than backward when determining yields at each stage of preparation, and hence to calculate the nutrients and yields of recipes at the final "ready-to-eat" stage when starting with items at the "as-purchased" or "ready-to-cook" stages.

The NRM can be difficult to use for nutrient analysis of published recipes, particularly when the edible portions of foods cannot be determined. It is more useful where a recipe can be kitchen-tested, such that waste factors and subsequent yields can be measured. However, published data on yields can help when direct measurement is unavailable.

The NRM facilitates the calculation of cooked yields when precooked quantities are known, and hence makes it possible to derive the precooked recipe portions or ingredient weights needed to generate a specified yield of the cooked product. This is valuable for standardizing costs and nutrient data and for adjusting ingredients and portions to meet differing cost or nutrition objectives.

The NRM makes it easier to match ingredients and preparation methods in the calculation of yields and nutrient values. There is much more data available for the raw or ready-to-cook forms of foods than for the cooked forms. The amounts of salt, fat, and other ingredients can be specified and varied, as can the amounts and types of discard. Micronutrient retention factors can be applied to most ingredients for a variety of cooking methods. Fat and moisture retention can be estimated, allowing nutrient and cost values to be generated for standardized portions of the cooked products. On the surface, therefore, the NRM appears to allow selection and variation of recipe contents and preparation methods without having to conform to the limited specifications imposed by use of cooked ingredients in the recipe analysis. However, this is not as simple a procedure as the description suggests.

**Using micronutrient retention factors.**

Estimates for vitamin losses from cooking were published by the USDA in ARS-62-13 (5) and an expanded provisional table was issued in October 1982 (6). The latter furnished values for 18 vitamins and minerals and for 50 preparation categories. To facilitate development of the recipe file for the latest NFCS nutrient data base, this table was expanded to 265 categories, allowing coders to more precisely match foods and cooking methods with those used in a broad range of recipes. Estimates for reheated preparations were included, although many values were extrapolated from the original 50 categories. The NFCS nutrient retention file was developed as part of a program for the calculation of recipes; as such, it could be adapted for other recipe analysis programs. To date, this expanded list has been released only as part of the NFCS recipe file tapes.

**Determining fat retention.**

In using the NRM, fat gains or losses due to cooking are usually calculated as a percentage of total weight of the recipe. The major source of fat retention data is USDA handbook H-102 (7), with tables also included in ARS-62-13. While these supply extensive information, they are by no means complete, and it is particularly difficult to find values for fried items. The handbook also combines this data with food waste and moisture retention values; as such, it is not as convenient to use or as efficiently assembled as is the micronutrient retention table. It takes more time to locate useful information.

As mentioned, these tables contain limited data for fried foods or recipes, which is most problematic for assessing deep fried foods, since fat absorption is not specified in recipes as an ingredient, and is difficult to measure directly. Absorption will vary with changes in cooking temperature and duration of frying, type of fat used, and type and amount of batter or other coatings applied. A single estimate of fat absorption is inadequate for many foods, and more extensive data are needed to account for variations in preparation and cooking.

Estimating fat levels for pan-fried foods is difficult where the amount of cooking oil is not specified. (Of course, this problem occurs with any method used for nutrient calculation.) The type of cookware, as well as the type of fat, ingredient coating, and time and duration of cooking allow for considerable variation in the amount of fat or oil needed. Where the recipe is kitchen-tested, an appropriate value can be derived and specified in a recipe file for a given set of preparation and cooking procedures. In contrast, such values are not readily available when calculating nutrient values from published recipes. Where the amount of frying fat is not specified, personal judgement is required, as there are few published guidelines for such recipes. This is particularly of concern for those attempting to produce a low-fat recipe by minimizing the total fat used for frying. In this situation, an estimate is needed of a lower boundary for added fat that minimizes the quantity while not severely compromising the integrity of the dish being prepared.

The aforementioned NFCS recipe tape was reviewed to determine whether values for fat retention were included that were not published in H-102. Such values could serve as a reference for others doing recipe analysis. Out of some 3000 recipes, 146 listed fat retention values, 23 with fat losses, and 123 with a net fat gain. Many of these are not contained in H-102, although they are largely derived from this and similar sources. Unfortunately, many foods of interest are contained in the NFCS primary ingredient file, which does not supply fat data of this type. More fat retention data, organized in a streamlined fashioned similar to the micronutrient retention tables, are needed to provide a comprehensive reference that can be adapted for use with nutrient analysis software.

**Moisture retention.**

When it is necessary to generate values for standardized (eg., 100 gram) portions of a cooked recipe, procedures for determining moisture gains and losses from cooking are needed. The NRM procedures for calculating moisture and fat retention are similar, and contained in the same publications. Likewise, it is difficult to find values for any dishes, as overall data are limited. As with fat, moisture gains and losses can vary with cooking time and temperature and with method of preparation, so a single value is really inadequate for many foods.

Again, the NFCS recipe file was examined for moisture retention data in calculated recipes. As with fat data, values are supplied as a percentage of the total weight of the uncooked ingredients. Values for moisture retention were found for 1255 items, many of which are not found in H-102 or ARS-13-63 although the data for the most part were derived directly from these sources. Again, these values could be organized in a file for ease of reference. As with the fat data, however, many items of interest are contained within the primary ingredient file where moisture retention values are not supplied. Hence values for NFCS recipes can best serve as a guide for comparing moisture retention in recipes whose ingredients and preparation are similar.

**Sodium retention.**

One nutrient not heretofore calculated by the NRM is sodium, despite the variability in foods that can result from differences in preparation. Like fat, varying quantities of salt or other sodium-containing products can be added to many recipes, and these amounts are not always specified. In processing, sodium retention can be affected by fat gains or losses, although the amounts would tend to be minor. An example where losses could be more significant is the roasting of meat where the exterior has been salted and much of that salt leaches with the fat drippings.

More significant quantities of sodium are gained or lost from boiling foods. Where an item containing sodium is steamed, or boiled in unsalted water, the sodium levels will be reduced. Often these losses are from the naturally-occurring sodium in the food, so that losses may be large as a percentage of total sodium, but less significant in absolute terms. More frequently, salt is added to water in cooking, and the amount of sodium gained is of interest. Estimating sodium absorption from boiling is difficult. If food composition tables give a single value, it is often an amount found in canned products. Such values are unreliable unless the same amount of sodium is added to the cooking water, and the processing is comparable. However, a recent (unpublished) pilot study conducted at the U.S. Army Natick Laboratory in Massachusetts suggests that sodium values can be calculated (6).

In that study, legumes, vegetables, and pasta products were boiled with varying amounts of salt added to the cooking water, and the cooked products were analyzed. Based on chloride measurements, it was found (as expected) that the amount of sodium in the cooked products rose as the amount of added salt was increased. In fact, the increase in sodium added to water produced a proportionate rise in the amount absorbed by the food. It was hypothesized that if a food was thoroughly cooked, an equilibrium in sodium concentration would result, such that:

$$\frac{\text{Water in food}}{\text{Total water}} = \frac{\text{Sodium in food}}{\text{Total sodium}}$$

This implies that, after cooking:

$$\text{Sodium in food} = \frac{\text{Sodium in boiling water} \times \text{Water in food}}{\text{Boiling water}}$$

In order to calculate the sodium in the cooked food using these formulae, it is necessary to know the beginning volume of cooking water and the moisture lost from evaporation, or to measure the volume of water remaining after cooking. The amount of natural sodium contained in the uncooked food and the amounts of water contained in the uncooked and cooked forms of the food can be estimated from food composition tables, such that added salt becomes the independent variable that determines the final sodium level in the cooked food. (However, the amount of sodium added can affect the amount of water absorbed or retained by some foods.)

Lab analyses of the chloride content of the cooked items allowed the sodium values to be derived. These values closely matched the predicted values for items that were thoroughly cooked. This data suggests that it may be quite easy to add sodium to NRM procedures, although more research using sodium analysis and more variations in cooking procedures will be needed to confirm these findings.

**Conclusions.**

Any method for calculating the nutrient content of recipes has procedural advantages and drawbacks. Having both methods available provides much greater flexibility and can help users produce better calculated values for a wide range of recipes and cooking processes, because the procedures seem to be complimentary. In fact, for many recipes, a combination of methods can be recommended - a procedure that was employed frequently in the development of the NFCS recipe files.

With proper programming, the NRM could be as fast and easy to use as any other procedure for recipe calculation, providing the necessary data are easily accessed. Drawbacks to widespread adoption of the NRM include the lack of data, particularly for moisture and fat retention, and the complex organization of current tables that makes them difficult to use efficiently. This would explain some of the reluctance to adopt this procedure. More data well organized would facilitate the integration of NRM into recipe analysis programs. But concern also exists for the validity and reliability of this method. There is at present little data available comparing this method to others and to analyzed values (7), although the USDA is sponsoring some validation studies at this time. Such data will be most valuable in determining whether inclusion of the NRM in recipe calculation is as worthwhile as proponents suggest.

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