How Accurate Are Your Nutrient Calculations? Why Culinary Expertise Makes a Difference

Food manufacturers and producers have been required to provide standardized information for the Nutrition Facts Label since passage of the Nutrition Labeling and Education Act of 1990 (1). Freshly prepared, institutional, and restaurant foods were not required to carry this information. At the national level, nutrient disclosure on menus is voluntary. Some local governments have mandated nutrition information on menu items of multi-unit restaurants and other government bodies are considering similar legislation. In 2008, several chain restaurants have been sued in class action lawsuits for inaccurate information on menus (typically underreporting calories and fat), so restaurants are understandably cautious about supplying nutrition information to customers. Today, however, all facets of the retail and foodservice industries are under pressure to provide nutrient facts and are searching for affordable and accessible ways to produce this information.

In response to this growing demand, a number of individuals and companies with little skill or experience in recipe development or food production have launched businesses using affordable software packages to provide recipe or nutrition analysis, typically in Nutrition Labeling and Education Act format. As these services proliferate, we believe it is time for every food and nutrition professional to ask: How were the data determined—by analysis or calculation? How confident am I that my calculations are accurate? What are the advantages of using my advanced culinary expertise for this service rather than relying on nutrition software alone? Do I have beyond-entry-level proficiency in the culinary competencies identified by the Food & Culinary Professionals Dietetic Practice Group? Have I protected myself from legal actions by clearly communicating sources of potential error, such as failure to adhere to standardized recipes, in contracts with foodservice clients? Does my professional liability insurance cover calculations for publication?

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ANALYSIS VS CALCULATION

True nutrient or nutrition analysis refers to an assay of select nutrients done by laboratory analysis using incinerated ash or chemical extraction to determine content. Newer techniques are used for extraction of bioactive chemicals. Each analytical laboratory has specific procedures for sample management and collection as well as procedures for quality assurance and control. Price depends on which nutrients are measured.

True nutrient analysis is typically used when precise data are essential, when the analysis will be entered into databases to be widely used, when nutrition claims will be made, when there are gaps in nutrient data, or when it is impossible to obtain data by calculation. Although the advantage of this method is accuracy, the disadvantages are expense, collecting the appropriate number and type of samples, and the time needed to perform laboratory analysis. Although a nutrient analysis will report exactly what is in the sample(s) provided, because of seasonal variations and variations in cooking techniques from sample to sample, even with excellent quality control, the resulting data are the best estimate when extrapolated to the whole.

Most registered dietitians and dietetic technicians, registered, use computerized databases for estimating the nutrient content of foods (2). This procedure is commonly called nutrient or nutrition calculation. Some practitioners refer to the process as nutrition analysis by calculation or nutrient analysis by database. Nutrient calculation software offers the advantages of ease, speed, and reduced cost, but is far less accurate than true nutrient analysis (3). Certain additional skills, including culinary expertise, are necessary to ensure optimal results.

NUTRIENT DATABASES

Interpreting raw nutrient data supplied by the US Department of Agriculture (USDA) National Nutrient Database for Standard Reference, original research, nutrient calculation software, or commodity boards or manufacturers presents a number of challenges (4). Many of the existing data are quite old and were determined when analytical methods were less precise. For example, approximately 20 years ago, new USDA data indicated that the cholesterol content of whole eggs was less than once believed because the method for assessing dietary cholesterol in foods had been updated (5). Other factors that can affect nutrient data include product variety, soil and growing conditions, ripeness at time of harvest, diet of animals, length of storage, preparation method, length of cooking, and shrinkage or volume change during cooking. In other words, an item in an ingredient list may not be the same in the finished product—and it is the

finished product that must be calculated. Accurate nutrient calculations require far more skill than selecting the right data based on the recipe ingredient list.

One common error made when calculating nutrient data is ignoring a blank in a database or substituting a zero for a blank. A blank means that reliable data has not been collected. A zero indicates that the food item contains none of the nutrient. For example, data are often missing or incomplete for fiber, *trans*-fatty acids, antioxidants, and phytochemicals. The absence of data in any nutrient category is not acceptable. Further search is required, such as contacting the manufacturer, grower, or commodity board; checking labels of currently available products or other databases to find the missing data; or using experience and professional judgment to estimate the missing value from a comparable product. Thus, while databases are useful tools for nutrient calculation, food and nutrition professionals often must dig deeper for complete and accurate information.

COMPLEXITIES OF CALCULATION

Providing nutrient data for recipes is common practice today, as restaurants, cookbook authors, culinary demonstrators, and cooking media respond to consumer demand for verification of the healthfulness of food. A simple recipe for fruit salad containing a specified amount of select fruits per portion involves calculating the nutrient contribution of each fruit, totaling the nutrient values, and dividing by the number of servings. Still, the result is only an estimate because the nutrient data for all fruits are just averages of multiple samples. This nutrient calculation is fairly straightforward. Few are so easy.

Standardization

The first step in calculating nutrient data is standardizing the recipe. It is important to be specific with both ingredients and amounts (see the Figure). For example, the ingredient chicken should specify with or without skin, white or dark meat, and cooking method. If a recipe calls for 1 c fresh spinach, the calculator must know or decide if it is raw whole leaf spinach, with or without stems. When determining which item to select within a database that most closely resembles a certain ingredient, calculators must look for key terms in the definition of the item. They also may weigh the ingredient and compare it to the weight or volume of a similar ingredient in the database. Experienced nutrient calculators maintain files detailing the weights of many foods in various forms so that they know, for example, how many grams of a vegetable in various cuts equal a cup (6-8).

Seasonings, especially high-sodium ingredients such as salt, should be listed by amount, not "to taste" or "as needed." (Omission of seasoning in a calculation creates a false impression, although it is acceptable to note that salt may be omitted to reduce sodium content of a recipe.) It may be necessary to prepare the recipe or to observe the recipe being prepared to clarify exact ingredients and amounts. Chefs may add oil and seasonings to food (and to flat grills) during cooking and then make final flavoring/seasoning adjustments. As a result, they often have no idea how much oil or salt they use. In this case, it may be necessary to put generous amounts of oil and salt on the mise en place tray, watch the chef prepare the food, and then measure the amount of oil and salt left after the dish is prepared. The difference in "before" and "after" is the ingredient amount actually used in the recipe for purposes of calculation. In addition to the amount of salt used, it is also important to clarify the type of salt. Kosher salt has less sodium per teaspoon than iodized table salt.

Some chefs and clients welcome suggestions for modifying ingredients, techniques, or portion sizes to improve the nutrient values; others do not. In any case, if a food and nutrition professional recognizes that a recipe is unclear, that any listed ingredient is not used in the method, or that the portions and yield are incompatible, the finding should be reported to the recipe developer for correction before the calculation is completed. Attention to such details contributes to a recipe's success and clearly demonstrates the value of the culinary food and nutrition professional's services.

Cooking Method

Understanding cooking method is also necessary for determining nutrient values. For example, a sautéed entrée is usually served in a sauce made from the drippings remaining in the pan. Sometimes rendered fat will be poured off before the pan is deglazed, and the sauce will be prepared by reducing added liquid (eg, stock, wine, and juice) and seasonings. The removed fat needs to be accounted for and subtracted from the calculation. The reduced liquid will lower volume but not caloric level. Some of the calories from alcohol, such as a wine or brandy used to deglaze a pan in the preparation of a sauce, may burn off during cooking, depending on cooking time and total volume of liquid. These losses need to be estimated and subtracted.

Thorough understanding of food preparation and cooking methods is also important when not all ingredients in a recipe will be consumed. For example, when a chicken breast is marinated before grilling and the unabsorbed marinade is discarded, only the absorbed marinade is calculated. A larger product surface area will absorb more marinade (chicken tenders vs chicken breast), as will a product that is more porous (mushrooms vs

Complete list of ingredients in recipe or formulation

- Include as much descriptive and relevant information as possible (eg, specify type of oil used, not just "vegetable oil").
- Identify the form and/or cut (eg, red onion, peeled, finely minced, 4 oz, 112 g).
- If a choice of ingredients is given (eg, fresh or canned tomatoes), identify the item most likely to be used. Place it first.
- Include recipe instructions if the process will alter the ingredients (eg, sautéing, grilling, or marinating).
- Indicate if ingredient has added salt, sugar, or other enhancement.
- If an ingredient is a purchased product from another source (eg, flavorings or seasonings), provide a resource (or product label) for nutrient values.

Amounts of ingredients in recipe

- For beans, grains, pasta, and rice, give the amount of dry or as purchased for the item as well as the cooked yield (eg, 1 c [185 g] dry brown rice=3 c [585 g] cooked brown rice).
- Provide measurements in either household measurements or weight. Weight measurements are more accurate. Because many households do not have scales, however, household measures are commonly used for consumer recipes.

Total yield, serving size, and number of servings for the recipe

- State how many servings the recipe yields (eg, serves eight 6-oz [180-mL] servings).
- If the ingredient is packaged, canned, or bottled, provide the size of the container (fluid ounces or cups; eg, canned, diced tomatoes, 14.5-oz can).
- The serving size on the Nutrition Facts Label for packaged food is regulated by the Food and Drug Administration. For packaged foods, calculate per standard serving of that food category. For recipes in cookbooks or for restaurant food, use the portion to be served for calculation.
- For restaurant food, one order should be calculated as one serving.

Additional information needed for Nutrition Facts Label

- Provide the dimensions of the proposed product label so that the most appropriate Nutrition Facts Label size and format can be developed.
- State details if the plan is to market several sizes of the product (eg, a small box with two chocolates and a larger one with six).

Nutrition claims

- If there are nutrition descriptors or claims about the product (such as "low fat" or "low sodium"), be sure claim criteria are met.

Figure. Optimizing recipes for nutrient calculations.

red peppers). If the food is cooked on a grill, some marinade will burn off. In addition, sodium in the marinade will extract liquid from the product being marinated.

A nutrient calculation for stock made with beef bones and mire poix (a combination of carrots, celery, and onion) that is later discarded must account for nutrients that have been infused into the stock. In this situation, the calculation can substitute a laboratory-analyzed value of the most similar product. Special consideration is also needed in calculating the nutrients in pureed and strained fruits and vegetables. For example, strained sauces must be adjusted for fiber and other nutrient losses. A food and nutrition professional with culinary expertise might estimate a percentage of loss or estimate remaining fiber based on other strained sauces or baby food.

Simply using the ingredient list to assign items numbers for calculation by computer without adjusting for losses or changes resulting from method of preparation or cooking can compromise the accuracy and quality of calculated nutrient values. Examples such as those outlined above illustrate that a certain level of culinary expertise may be necessary to make adjustments for the influence of food preparation and cooking methods on the nutrient content of a recipe.

Subrecipes and Yield

Determining the per-portion nutrient contribution of subrecipes and calculating yield are typically more complex than calculating the value of a single recipe that does not have various components plated and served together as one dish. Calculations for restaurant menu items can be particularly challenging. These steps in the nutrient calculation process can also require culinary expertise beyond what packaged software offers.

Some recipes have several subrecipes. For example, many fine restaurants serve a main item, on a bed of something, topped with a small amount of one or more sauces, and garnished with an edible garnish. The one "recipe," as served, may use varying amounts of each subrecipe. Consequently, a sauce subrecipe may make 16 servings of 1 T each, while the bed of vegetables or salad subrecipe makes enough for eight servings. In this case, it is necessary to determine the single-serving portions of each subrecipe and then total the values for one serving of the main dish fully plated. A photo of the plated food can be used to confirm the amount of sauces served per portion.

Yield is best determined by an actual weight or measure of the finished product. It is inaccurate to add weights and/or volumes of raw ingredients to determine yield. Combinations of ingredients and cooking methods can alter yield volume significantly. For example, when reducing a sauce or baking a cake, moisture is lost, thus reducing final yield weight and increasing nutrients per gram (9).

Yield is used to calculate per-portion nutrient content. A very large volume of ingredients that yields only

four or six servings or a low volume of ingredients that is meant to serve many will raise a red flag to an experienced calculator. This kind of situation often requires that the full recipe be prepared, the yield measured, and the number of portions re-evaluated.

PRESENTING THE FINAL CALCULATION

Given the ease and power of computerized nutrient calculations, the resulting data will often be carried to the hundredth decimal. This result creates a false sense of accuracy and confidence in the numbers. Because all nutrient calculations are estimates, numbers should be rounded according to the Food and Drug Administration's established rounding rules for product labels (10). In addition, nutrient calculation information should always carry a disclaimer stating that the findings are an estimate based on calculations from whatever databases were used along with the professional judgment of the person who performed the calculation. Noting that any changes in amount or type of ingredients or preparation that deviates from the standardized recipe makes the calculation invalid may provide some legal protection.

MANAGING THE UNKNOWN

One of the biggest challenges in calculating nutrient data for recipes is finding data for ingredients not listed in the USDA nutrient database or in reliable nutrient calculation software. Manufacturers, distributors, and trade associations can be sources for this information. Nutrient data for ethnic and imported ingredients are becoming available as these foods grow in popularity.

There are many claims that organic, heirloom, or artisanally grown products provide higher values of certain nutrients than do conventional varieties, but nutrient databases do not reflect differences that may exist. Also, much of the data reporting significant differences in organic and conventionally grown produce has not been published in peer reviewed journals and methodologies of many reports have been criticized. Clearly, the extent of the difference is portrayed quite differently in organizations that are advocates of organic or conventional produce and even among scientific groups (11,12). Much research on the antioxidant and phytochemical content of organic foods is underway. If exactness is critical, as in a nutrition label, a product can be submitted to a laboratory for nutrient analysis. Although labeling laws allow a certain percent of variance from the numbers presented on the product, it is wise to avoid liability by using methods that maximize accuracy.

Equally important is the need for updating and providing complete analysis data for foods within existing databases that have not been retested in many years. The nutrient values for many basic foods have changed since they were analyzed decades ago, and analytical methods have improved dramatically over time. The American Dietetic Association has long advocated government funding of nutrition research, including updating and upgrading USDA's Agricultural Research Service Food Composition Laboratory. Perhaps recent food safety crises will provide the focus and funding to improve nutrient databases.

CONCLUSIONS

The food community and food and nutrition professionals should understand that accurate nutrient calculations require far more knowledge and skill than simply entering codes for recipe ingredients from nutrient databases. Competencies in culinary nutrition, experience in the nuances of nutrition calculations, access to excellent databases, and strong cooking skills increase the accuracy and quality of nutrient calculations. Development of these competencies is requisite for the quality practice of registered dietitians and dietetic technicians, registered, who include nutrient calculation in the services they provide.

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