# PROBLEMS ASSOCIATED WITH RECIPE ANALYSIS

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The Nutrient Data Research Branch at USDA's Human Nutrition Information Service is responsible for the publication of Agriculture Handbook No. 8, "Composition of Foods...Raw, Processed, Prepared." We are in the process of revising the handbook in sections by food group. The section to which I am currently assigned is the one covering mixed dishes. For this handbook section, we need values for the cooked forms of mixed dishes since this is the form in which they are consumed. In trying to derive nutrient values for these dishes, we have been looking at various ways to calculate the values from ingredient information, based on formulas or recipes. Of course, we want to do this work by computer. Dr. Jane Wyatt, at Oregon State University, has undertaken a research project to analyze 25 mixed dishes, raw and cooked. The dishes were prepared from recipes, were weighed and analyzed raw and cooked. We have been using results of this research to test the appropriateness of the various methods for calculating recipes from ingredient information.

There are several methods for calculating the nutrient content of a cooked dish, given the raw recipe. I will discuss three methods we have used, and will compare our calculated values with Dr. Wyatt's analyses. In the first method, we apply a retention factor to each raw ingredient for each nutrient to be determined, and we apply a yield factor to the overall weight of the recipe to account for changes in moisture or fat content during cooking. For this method a computer program has been developed. The program uses the Standard Reference Tape which has been discussed earlier.

The second method uses nutrient data for the cooked form of each ingredient. Retention factors for the nutrient are, therefore, not needed but it requires information about yield of each cooked ingredient from raw material. The third method uses nutrient data for each raw ingredient, as in the first method, but a retention factor for the whole dish (not each ingredient) is used for each nutrient. The retention factors and yield information needed for the calculations of each method are found in--

Ag Handbook No. 102--Food Yields

ARS 62-13--Procedures for Calculating Nutritive Values of Home Prepared Foods--Tables 2 and 22

Provisional Table on Percent Retention of Nutrients in Food Preparation

Because the dishes I have worked with are the casserole type--that is, all the ingredients are in the dish, nothing is drained or discarded--I will limit my discussion to vitamins. Any minerals that might leach out of the ingredients would be retained in the broth and there would not be any destruction of minerals. I will discuss three B-vitamins and vitamins A and C.

The first dish is a beef stew without tomatoes (recipe, Table 1). The NDB number represents the identification number for the Standard Reference Tape. We have already converted the volume measure to weight in grams. The ingredients in order of weight are water, beef, potatoes, onions, carrots, frozen peas, flour, salad oil, salt and pepper. The beef is coated with flour and browned in the oil. Water is added and the meat simmered. The remaining ingredients are added and cooked until tender. In this dish, all raw ingredients are added to the "pot" and the only change after cooking is a loss of moisture. Table 2 shows the vitamin content of beef stew before cooking, as calculated from the nutrient data base.

In the first method of calculation, we use the nutrient content of the raw ingredients and apply a retention factor for each nutrient. These retention factors are found in either ARS 62-13 or the Provisional Table. For the first ingredient, flour, multiplying by the retention values for flours and grains from the Provisional Table (thiamin 80 percent, riboflavin 90 percent, and niacin 90 percent) we get .38, .26, and 3.5 milligrams/100 grams for the content of "cooked" flour (Table 3). As mentioned before, we already have a computer program to calculate a recipe for this method. The retention factors are stored in the program. When we enter the identification code for flour, we enter the appropriate code for this set of retention factors. Since wheat flour contains no vitamin A or C, we can disregard them for this ingredient. The factors we will use for both onions and carrots are those for root vegetables prepared from raw and drained. In our beef stew, the vegetables actually are not drained but this is the best retention figure available to us. If our calculation gives a lower vitamin content than was found on actual analysis, this retention factor might be the cause. For potatoes, we will use factors for potatoes boiled without the skin and drained, although like the root vegetables, they are not drained. The factors for peas will be those for starchy vegetables prepared from frozen and drained. Braised beef seems to be the best match for the beef in our stew, so those factors will be used for the B-vitamins in beef. Since no factor is given for vitamin A retention in beef or pork, the 75 percent retention for chicken meat will be applied.

Now we can add the values to determine the content for the total "cooked" dish. If this is divided by the weight of the cooked dish, we can calculate the amount of each nutrient per 100 grams. Determining the weight of the cooked dish presents another problem. The total weight of the raw dish is 6,649 grams. For beef stew, the only change is a moisture loss during cooking. Using a value of 13 percent for evaporation loss in stew, as suggested in ARS 62-13, will give a weight for the cooked dish of 5,784 grams. The values we have derived for beef stew using this first method of calculation are .069, .071, 1.28 mg for thiamin, riboflavin and niacin, respectively; 1,742 IU for vitamin A, and 6.3 mg for vitamin C per 100 grams (Table 4).

The second method for calculating cooked dishes is to convert the weight of the raw product to the weight we would expect after cooking and apply the nutrient composition of the cooked product. The overall weight change will again be a moisture loss of 13 percent--or 864 grams--with a total weight of 5,784 grams. Since the vegetables remain in the cooking container, we will not calculate a moisture change for them. The stewing beef is browned in oil and the remaining ingredients are added to the cooked beef so there is no dripping loss or fat uptake. There will be a loss of volatiles in the beef and the best estimate for this loss is 17 percent from Food Yields--Item #304, pan fried steaks, boneless. The weight of cooked beef is 1,130 grams, a loss of 232 grams. The remaining moisture loss, 632 grams, we will deduct from water to give 760 grams of water in the "cooked" stew.

If we change these weights and use codes for cooked items, with no retention factors, the computer will generate the nutrient composition per 100 grams for cooked stew. The values derived by our second method are .08, .08, 1.7 mg for thiamin, riboflavin, and niacin, respectively; 1,845 IU for vitamin A, and 7 mg for vitamin C per 100 grams (Table 4). These values are slightly higher than those derived by method one--perhaps because we used retentions for drained vegetables.

The third and last method for calculating "cooked" dishes is to apply the dish retentions to the raw recipe. For example, one retention for each nutrient per dish, instead of a retention for each nutrient in each ingredient. In method one, when we applied retention factors to raw data, we did derive a total for each nutrient in the cooked dish. We have the total for the raw dish and by dividing the cooked total by the raw total we get our "dish retention" (Table 5). A dish retention could have derived by method two also. This third method involves only one calculation for each nutrient in the whole dish, not separate calculations for each ingredient, and if the resulting values seem correct, it would be simpler and could be easily handled by computer. The results for the third method are .069, .072, and 1.28 mg for thiamin, riboflavin, and niacin, respectively; 1,743 IU for vitamin A, and 6.5 mg for vitamin C per 100 grams (Table 4).

These results are very close to Method 1 because the dish retention factors for this paper were directly derived from the results of Method 1. Studies are being conducted to provide a basis for dish retentions. If any uniformity could be found for dishes cooked in a certain way--that is, oven baked or cooked on top of the stove--perhaps a set of factors could be derived for the entire group. Whether length of time in cooking or temperature to which mixtures are cooked is the determining condition has not been resolved. The source of carbohydrate--that is, pasta, legume, or rice--and the pH of the dish may also influence the retention of vitamins on cooking.

To see how well our methods of calculation are predicting the actual content of the cooked dishes, let us look at Dr. Wyatt's laboratory results. For beef stew, the analytical values are thiamin .07, riboflavin .09, niacin 1.3 mg, vitamin A 4,007 IU, and vitamin C 3 mg per 100 grams (Table 4). One discrepancy seems very obvious. The analyzed vitamin A value of over 4,000 IU is very high--the raw stew had a content of 1,605 IU. The laboratory repeated the analyses on both dishes and confirmed the first results. The research is not completed at this point, but the explanation is that the extraction is more efficient when the dish is cooked.

The dish we have been considering so far, beef stew, has only a moisture loss during cooking. An additional problem exists when we "cook" a dish like spaghetti, macaroni and cheese, or beans and franks in which water is absorbed by a raw ingredient. Let us consider spaghetti with tomato sauce (recipe, Table 6). Using the first method--raw ingredients times retention factors--the nutrient content of the dish would not be affected by this water absorption (Table 7). The problem would be in arriving at a weight of cooked dish. We are given a weight of raw spaghetti of 680 grams and using a yield factor of 282 percent, from Food Yields, we get 1,918 grams as the weight of cooked spaghetti.

ARS 62-13 gives an evaporation loss of 10 percent for spaghetti in tomato sauce. Our dish weight with 1,918 grams of cooked spaghetti is 3,344 grams, and a 10 percent loss gives 3,010 grams as the weight of cooked spaghetti in tomato sauce. The nutrient content per 100 grams is .18, .10, and 1.6 mg for thiamin, riboflavin, and niacin, respectively; 809 IU of vitamin A, and 14.4 mg of vitamin C per 100 grams (Table 8). We can derive "dish retentions" as we did for beef stew.

In method 2, we would use the same weight for cooked spaghetti and use the nutrient composition for cooked spaghetti, cooked onion, and cooked peas. Our weight of cooked dish would be the same as in method 1 and the results of this calculation per 100 grams are .14, .09, and 1.5 mg for thiamin, riboflavin, and niacin, respectively; 850 IU of vitamin A and 15.0 mg of vitamin C per 100 grams (Table 8).

Using the "dish retention" the same way we did in the beef stew we get .18, .10, and 1.61 mg for thiamin, riboflavin, and niacin, respectively; 808 IU for vitamin A, and 14.4 mg of vitamin C (Table 8).

The laboratory-analyzed results for spaghetti with tomato sauce are thiamin .13 mg, riboflavin .07 mg, niacin 1.8 mg, vitamin A 704 IU, and vitamin C 4.6 mg (Table 8). The calculated values for vitamin C are higher than the analyzed value. There may actually be destruction in freeze-drying the sample.

A dish with fat uptake on cooking, zucchini fritters (recipe, Table 9), presents additional problems to be considered in calculating the cooked dish. ARS 62-13 gives 35 percent evaporation loss and a 14 percent fat uptake on cooking for corn fritters. We will use these figures for zucchini fritters. The first method with raw ingredients and retention factors is straightforward, but there is a net loss of 21 percent due to evaporation and fat uptake. The weight of the raw dish is 1,754 grams and deducting 21 percent or 368 grams gives a weight of cooked dish of 1,386 grams. The values obtained using this method are .22, .26, and 2.0 mg for thiamin, riboflavin, and niacin, respectively; 268 IU for vitamin A and 5 mg for vitamin C (Table 10).

In using the calculation method 2, we need a yield figure for zucchini. The value given in Food Yields #102 is 85 percent so we have 464 grams of cooked zucchini--a moisture loss of 82 grams. As stated before, we would have a 35 percent total moisture loss but we have already accounted for 82 grams, or 5 percent, of the total, so we can apply an additional 30 percent to the recipe. The 14 percent fat uptake calculation must be done before evaporation and we find 245 grams of fat is absorbed. The values for this calculation are thiamin .26 mg, riboflavin .27 mg, niacin 2.1 mg, vitamin A 252 IU, and vitamin C 3 mg per 100 grams (Table 10). Applying dish retentions gives .22, .26, and 2.0 mg for thiamin, riboflavin, and niacin, respectively; 270 IU for vitamin A, and 5 mg for vitamin C (Table 10).

The analytical results for zucchini fritters are .22, .30, and .86 mg for thiamin, riboflavin, and niacin, respectively; and 349 IU for vitamin A per 100 grams (Table 10). Our calculations for riboflavin are slightly lower than analyzed but niacin appears to be over-estimated. More vitamin A was found on analysis but vitamin C was apparently below the limits of detection.

I have not reached a conclusion as to which method is best. We do have a computer program for method 1 which will apply retention factors. Our program will handle method 2 also, when the identification codes and appropriate yields are inserted for cooked ingredients.

For our purposes, in the mixed dish section, a "dish retention" calculation would be ideal. Much of the data that comes from manufacturers is for uncooked dishes. We have no recipe with which to do calculations, so the total dish retention would be helpful.

Obviously, more research is needed before we can determine "dish retentions" which can be applied to a group of dishes. Our 25 dishes have given us an overview of the problems involved and a project is currently underway to study in more detail the conditions that affect retention.

TABLE 1.--BEEF STEW RECIPE

| Standard reference name | NDB no. | Weight/grams |
|---|---|---|
| Wheat flour-------- | 94390 | 74.0 |
| Salt---------- | 89630 | 19.8 |
| Pepper---------- | 2030 | 1.2 |
| Beef, round, raw--- | 73520 | 1,362.0 |
| Oil, soybean------- | 4034 | 51.7 |
| Water---------- | 97010 | 1,392.0 |
| Onion, yellow, raw- | 84121 | 1,048.0 |
| Potato, raw-------- | 87851 | 1,268.0 |
| Carrots, raw------- | 76190 | 984.0 |
| Peas, frozen------- | 85291 | 448.0 |
| Total weight | | 6,649.0 |

TABLE 2.--VITAMIN CONTENT OF BEEF STEW BEFORE COOKING

| Ingredient | Thiamin | Riboflavin | Niacin | Vitamin A | Vitamin C |
|---|---|---|---|---|---|
| | Mg | Mg | Mg | IU | Mg |
| Flour-------- | .47 | .29 | 3.9 | 0 | 0 |
| Salt--------- | .00 | .00 | .0 | 0 | 0 |
| Pepper------- | .00 | .00 | .0 | 2 | 0 |
| Beef--------- | 1.18 | 2.45 | 66.1 | 341 | 0 |
| Oil---------- | .00 | .00 | .0 | 0 | 0 |
| Onions------- | .31 | .42 | 2.1 | 419 | 105 |
| Potatoes----- | 1.27 | .51 | 19.0 | 0 | 254 |
| Carrots------ | .59 | .49 | 5.9 | 108,240 | 79 |
| Peas--------- | 1.43 | .45 | 9.0 | 3,046 | 85 |
| Total | 5.25 | 4.61 | 106.0 | 112,048 | 523 |

TABLE 3.--WHEAT FLOUR (per 74 grams)

| Nutrient | Raw value | | Retention | | Cooked value |
|---|---|---|---|---|---|
| Thiamin-----Mg-- | .47 | X | .80 | = | .38 |
| Riboflavin--Mg-- | .29 | X | .90 | = | .26 |
| Niacin------Mg-- | 3.9 | X | .90 | = | 3.5 |
| Vitamin A---IU-- | 0 | | -- | | 0 |
| Vitamin C---Mg-- | 0 | | -- | | 0 |

TABLE 4.--VITAMIN CONTENT OF COOKED BEEF STEW (per 100 grams)

| Nutrient | Calculated by-- | | | |
|---|---|---|---|---|
| | Method 1 | Method 2 | Method 3 | Analyzed |
| Thiamin-----Mg---- | .069 | .08 | .069 | .07 |
| Riboflavin--Mg---- | .071 | .08 | .072 | .09 |
| Niacin------Mg---- | 1.28 | 1.7 | 1.28 | 1.3 |
| Vitamin A---IU---- | 1,742 | 1,845 | 1,743 | 4,007 |
| Vitamin C---Mg---- | 6.3 | 7 | 6.5 | 3 |

TABLE 5.--DISH RETENTIONS

| Nutrient | Beef stew | Spaghetti | Zucchini fritters |
|---|---|---|---|
| | % | % | % |
| Thiamin----- | 76 | 71 | 81 |
| Riboflavin-- | 89 | 82 | 93 |
| Niacin------ | 70 | 76 | 91 |
| Vitamin A--- | 90 | 95 | 96 |
| Vitamin C--- | 73 | 95 | 70 |

TABLE 6.--SPAGHETTI WITH TOMATO SAUCE RECIPE

| Standard reference name | NDB No. | Weight/grams |
|---|---|---|
| Onion, yellow---------- | 84121 | 100.0 |
| Garlic, cloves---------- | 80290 | 3.2 |
| Oregano---------- | 2020 | .4 |
| Salt---------- | 89630 | 10.0 |
| Pepper---------- | 2030 | 1.5 |
| Tomato paste, canned------ | 92952 | 340.0 |
| Tomato puree, canned------ | 92960 | 850.0 |
| Sugar, granulated--------- | 92300 | 20.8 |
| Grated parmesan---------- | 1032 | 100.0 |
| Spaghetti, enriched, dry-- | 91570 | 680.0 |
| Total weight | | 2,105.9 |

TABLE 7.--B-VITAMIN CONTENT OF SPAGHETTI WITH TOMATO SAUCE

| Ingredient | Weight in recipe | Content in recipe | | Retention factor | | Content retained |
|---|---|---|---|---|---|---|
| | g | Mg | | | | Mg |
| | | | | Thiamin | | |
| Onion---------- | 100.0 | .03 | X | .85 | = | .03 |
| Garlic---------- | 3.2 | .01 | X | 1.00 | = | .01 |
| Tomato paste---------- | 340.0 | .68 | X | .95 | = | .65 |
| Tomato puree---------- | 850.0 | .76 | X | .95 | = | .72 |
| Parmesan--------- | 100.0 | .04 | X | .90 | = | .04 |
| Spaghetti-------- | 680.0 | 5.98 | X | .65 | = | 3.89 |
| Other ingredients | 32.7 | -- | | -- | | -- |
| | 2,106. | 7.5 | | | | 5.34 |

TABLE 8.--VITAMIN CONTENT OF COOKED SPAGHETTI WITH TOMATO SAUCE (per 100 grams)

| Nutrient | Calculated by-- | | | |
|---|---|---|---|---|
| | Method 1 | Method 2 | Method 3 | Analyzed |
| Thiamin-----Mg---- | .18 | .14 | .18 | .13 |
| Riboflavin--Mg---- | .10 | .09 | .10 | .07 |
| Niacin------Mg---- | 1.60 | 1.50 | 1.61 | 1.8 |
| Vitamin A---IU---- | 809 | 850 | 808 | 704 |
| Vitamin C---Mg---- | 14.4 | 15.0 | 14.4 | 4.6 |

TABLE 9.--ZUCCHINI FRITTER RECIPE

| Standard reference number | NDB No. | Weight/grams |
|---|---|---|
| Wheat flour------- | 94390 | 474.0 |
| Baking powder----- | 71320 | 12.0 |
| Salt-------------- | 89630 | 19.5 |
| Egg--------------- | 1123 | 324.0 |
| Milk, 3.3% fat---- | 1077 | 366.9 |
| Vegetable oil----- | 84017 | 12.0 |
| Zucchini, raw----- | 91970 | 546.0 |
| Total weight | | 1,754.4 |

TABLE 10.--VITAMIN CONTENT OF COOKED ZUCCHINI FRITTERS
(per 100 grams)

| Nutrient | Calculated by-- | | | |
|---|---|---|---|---|
| | Method 1 | Method 2 | Method 3 | Analyzed |
| Thiamin-----Mg---- | .22 | .26 | .22 | .22 |
| Riboflavin--Mg---- | .26 | .27 | .26 | .30 |
| Niacin------Mg---- | 2.0 | 2.1 | 2.0 | .86 |
| Vitamin A---IU---- | 268 | 252 | 270 | 349 |
| Vitamin C---Mg---- | 5 | 3 | 5 | * |