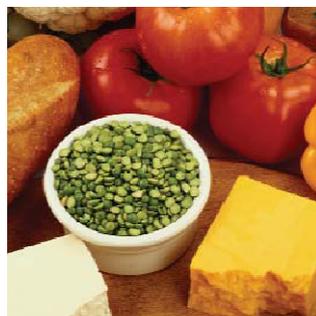
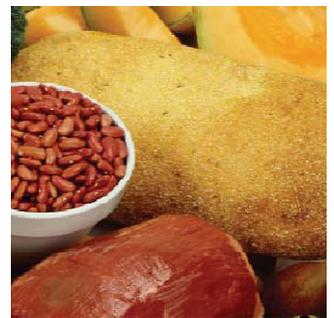


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Proposal for the harmonisation of recipe calculation procedures

WP2.2 Composite Foods



Project no.FP6 - 513944

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WP2.2 Composite foods

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1 Glossary

The following definitions are used in this report:

Food:

Raw food or dish intended for human consumption.

Dish:

A food that has been prepared at home or by industrial or catering processes.

Ingredient:

A food item included in a recipe.

Recipe:

A list of ingredients, including the amounts, which are needed to prepare a dish.

Edible portion:

Term refers to the edible material remaining after the inedible waste (e.g. bones, stones, and peel) has been trimmed away.

Yield factor:

Term is used for what is retained *in weight* after food preparation, processing or other treatment. Weight change is a result of moisture (e.g. water) and solid (e.g. fat) losses or gains.

Retention factor:

Term is used for what is retained *in nutrient content* after food preparation, processing or other treatment. This is usually applied to changes in water, fat, vitamin and mineral content.

NLG factors:

Nutrient losses and gains (NLG) factors are a general term, which includes both yield and retention factors. We recommend the use of terms yield and nutrient retention factors instead of NLG factors.

Ingredient level:

Term is used when yield factor is applied separately to the weight of each ingredient or when retention factor is applied separately to nutrient content of each ingredient.

Recipe level:

Term is used when yield factor is applied to the whole weight of a dish or retention factor is applied to the total nutrient content of a dish.

2 Introduction

Composite foods are major items in the European diet, which makes it important to have good quality data on composite foods in food composition databases (FCDB). Composite foods already exist in large numbers in European FCDBs, as was noted in the trend report prepared by WP2.2 (Ovaskainen, Krines et al. 2005). Energy and nutrient content of composite foods are usually estimated by using recipes. Because of the abundance and ever increasing variety of these kinds of foods it is impossible to analyze the nutrient composition of all composite dishes, as this would considerably raise the cost of food analysis for a comprehensive FCDB.

The nutrient content of composite foods is calculated in recipe calculation procedure by using the nutrient content of ingredients. Weight changes of ingredients during cooking and food processing are taken into account by using yield factors, whereas changes in the nutrient content of ingredients are taken into account by using nutrient retention factors. There are a lot of different recipe calculation procedures available and factors used vary between different European countries. However, a standardized procedure for the management of composite foods in European FCDBs is desirable to enable between country comparisons. Hence the harmonization of recipe calculation procedures is necessary in Europe.

Since the 1980's several international initiatives have already tackled the harmonization issue. The FLAIR Eurofoods-Enfant project's objective was to improve quality and compatibility of food consumption and food composition data in Europe. This project collected a huge inventory of nutrient losses and gains factors (Bergström 1994), but no guidelines concerning the use of these factors were published. In 1991 International Network of Food Data Systems (INFOODS) coordinated by Food and Agriculture Organization (FAO) published guidelines for estimating the nutrient content of multi-ingredient foods based on the nutrient contents of the ingredients (Rand, Pennington et al. 1991).

In the late 1990s an inter-compiler comparison was carried out in Northern Europe (Becker 2002; Norfoods 2002). In this project each participant calculated the energy and nutrient content of a standard daily menu. Differences in the definitions of nutrients were observed and recommendations were given for those aspects. The principles for recipe formulation and nutrient retention factors used also differed but no recommendations were eventually given for recipe calculation procedures, although it was pointed out that the use of same yield and retention factors would significantly reduce the noted differences.

The European Prospective Investigation into Cancer and Nutrition (EPIC) studies diet, health and lifestyle in ten European countries. This project has developed a standardized EPIC Nutrient database, in which common nutrient losses and gains factors as well as a common recipe calculation procedure is used (Slimani, Deharveng et al. 2007).

The objective of this report is to review the most commonly used recipe calculation procedures alongside examples of recipe calculation procedures used by EuroFIR partners. Finally a proposal for the recipe calculation procedure for EuroFIR partners is given. The proposal will be used to achieve common understanding on recipe calculation procedures among EuroFIR partners and eventually to launch calculation guidelines to be applied in the management of European FCDBs. Common guidelines are especially useful for partners not yet using recipe calculation.

3 Recipe calculation methods

The starting points for recipe calculation are a recipe – a list of ingredients and the nutrient content of uncooked ingredients. During preparation and cooking there are changes, which affect both the weight and the nutrient content of ingredients (Figure 1). These changes are taken into account in recipe calculation procedures by using edible portion and both yield and retention factors. However, the problem is how to apply these data in order to get

the nutrient content of a cooked composite food. The general compilation process for recipe calculation is presented in Appendix 1.

This report shows that there are several ways to do recipe calculation. Yield and retention factors can be applied at two different levels. Recipe level means that yield factor is applied to the whole weight of a dish or retention factor is applied to the total nutrient content of a dish. Ingredient level means that yield factor is applied separately to the weight of each ingredient or retention factor is applied separately to nutrient content of each ingredient. To avoid confusion it must be emphasized that yield factor is related to weight change and retention factor to the change in nutrient content.

In this chapter commonly used recipe calculation procedures are described as in the original publication. Later in chapter 3 a few examples of recipe calculation procedures used in European FCDBs are presented. The selection of these examples was based on the trend report (Ovaskainen, Krines et al. 2005). The detailed calculation examples can be found in Appendix 2.

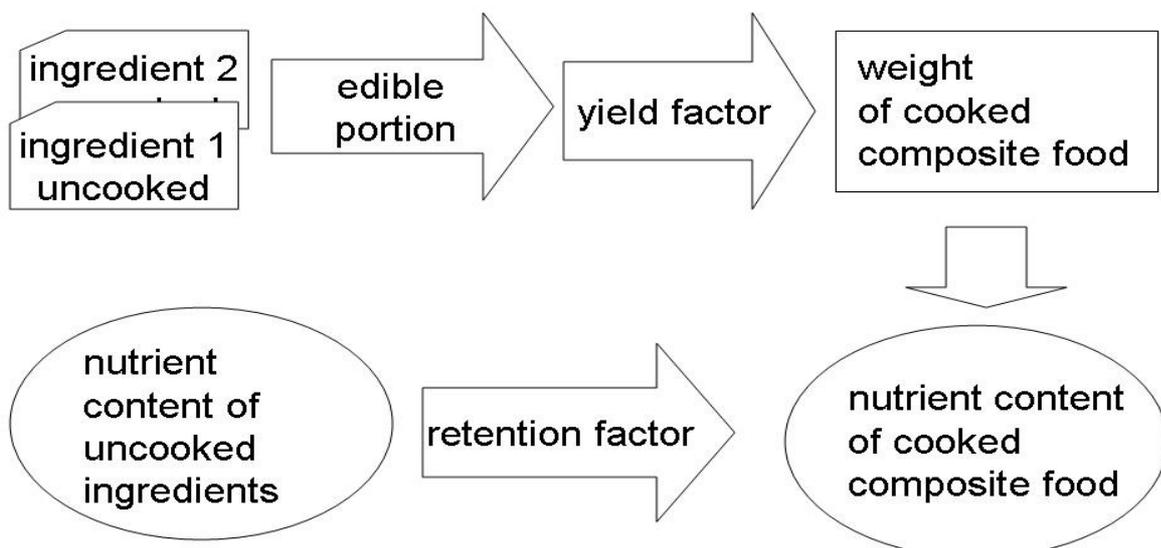


Figure 1. Overview of recipe calculation procedure

3.1 INFOODS method

In the INFOODS method for recipe calculation retention factors are taken into account at ingredient level, whereas yield factors for water and fat change are applied at recipe level.

Recipe calculation procedure recommended by INFOODS (Rand, Pennington et al. 1991):

1. Select or develop appropriate recipe.
2. Collect weight and nutrient content data for each ingredient
3. Correct ingredients to edible weights where appropriate.
4. Adjust the nutrient values of ingredients for effect of cooking.
5. Apply the retention factors to the nutrient levels in the raw ingredients.
6. Sum weights of ingredients to get total raw weight of recipe.
7. Sum nutrient values of ingredients to obtain nutrient value of recipe.
8. Determine total weight of recipe after cooking by applying yield factors. Adjust nutrient levels to reflect changes in fat or water.
9. Determine the quantity of prepared food produced by the recipe.
10. Determine the final values per weight (e.g., per 100 g), volume (e.g., per cup), or serving portions as desired.

3.2 British method

In the British method retention factors are applied at ingredient level according to each ingredient's food group and method of cooking (Food Standards Agency 2002). Retention

factors are not applied to minor ingredients such as herbs and spices. Yield factor for water change is applied at recipe level. The change in fat content cannot be calculated directly in the British method. In these cases the water and fat content of cooked dishes should be analyzed.

The nutrient value for a dish is calculated based on the weights of the raw recipe ingredients.

1. Correct the ingredient weights due to different losses during the preparation (refuse due to ingredients left on utensils etc.).
2. Weigh the raw dish.
3. Cook the dish.
4. Weigh the cooked dish.

If the weight change depends on water alone, the composition of the cooked dish is calculated as follows:

Nutrient content of cooked dish per 100 grams =
total nutrient content of raw ingredients / weight of cooked dish x 100

Water content of cooked dish per 100 grams =
(water in raw ingredients-weight loss on cooking) / weight of cooked dish x 100

If a recipe is to be calculated from the ingredients and weight change is due to water, but the weight of the cooked dish is unknown, this may be estimated by using the percentage weight change from a similar recipe as follows:

Weight of cooked dish =
[Weight of raw ingredients x (100 - % weight loss of similar dish)]/100

For recipes which gain weight on cooking:

Weight of cooked dish =

$[\text{Weight of raw ingredients} \times (100 + \% \text{ weight gain of similar dish})] / 100$

3.3 Yield factor method

In the yield factor method yield factors for pre-preparation, preparation, cooking and consumable (edible portion) are applied at ingredient level (Powers and Hoover 1989). Retention factors are not taken into account.

The calculation procedure is following:

1. Convert stated weight of ingredients to cooked weight by sequentially multiplying ingredient amounts by preparation and cooking yield factors.
2. Multiply the cooked weight of each ingredient by a consumable yield factor to determine the edible-portion weight.
3. Convert ingredient weights to 100-g units. E.g. if an ingredient weight is stated in grams, divide the ingredient weight by 100.
4. Calculate the value for each nutrient per ingredient by multiplying ingredient weight (calculated in step 3) by the appropriate nutrient profile per 100-g portion.
5. Sum the nutrient value calculated for each ingredient to determine the nutrient values of the total recipe

3.4 Retention factor method

In the retention factor method retention factors are applied at ingredient level, but yield factors for water and fat are applied at recipe level (Powers and Hoover 1989; Beecher and Matthews 1990). The procedure is as follows:

1. Convert the measure of each ingredient to the corresponding gram weight.
2. Multiply the weight of each ingredient by the appropriate refuse factor and subtract the weight of refuse from starting weight to determine the edible-portion weight of each ingredient.
3. Multiply the edible-portion weights for each ingredient by each nutrient value per 100-g portion. Divide that value by 100 to determine each nutrient value per ingredient.
4. If the nutrient profile does not match the form of the food as served, apply retention factors to the nutrient values of each ingredient.
5. Sum the uncooked edible-portion weights of ingredients to compute the total uncooked gram weight of the recipe.
6. Sum the adjusted nutrient values of the ingredients (steps 3 and 4) to determine the nutrient values of the total recipe.
7. Using an assigned percentage of moisture change, determine the grams of moisture gained or lost from cooking, and adjust the moisture content to account for the gain or loss of moisture in the cooked dish.
8. Using the assigned percentage of fat change, determine the grams of fat gained or lost from cooking, and adjust the energy content and lipid content to account for the gain or loss of fat in the cooked dish.
9. Add the change in moisture content in grams (step 7) and the change in fat content in grams to the total uncooked weight of the recipe (step 5) to determine the cooked weight of the recipe.
10. Divide the cooked weight of the recipe computed in step 9 by 100 to determine the number of 100-g units per recipe, Divide the value for each nutrient for the total

recipe (step 6, 7, and 8) by the number of 100-g units to calculate each nutrient value per 100-g portion.

3.5 Summing method

In the summing method yield and retention factors are not taken into account at all (Powers and Hoover 1989). If this method is applied to cooked ingredients, the nutrient values and the weight of ingredients should correspond to the respective values of cooked food.

1. Convert measures of ingredients to corresponding gram weights.
2. Sum the gram weights of each ingredient to determine the gram weight of the recipe.
3. Divide the ingredient gram weights by 100 to determine the number of 100-g units for each ingredient.
4. Multiply the values calculated in step 3 for each ingredient by the nutrient values per 100-g portion to determine the nutrient values per ingredient.
5. Sum the nutrient values of the ingredients to determine the total nutrient content of the recipe.

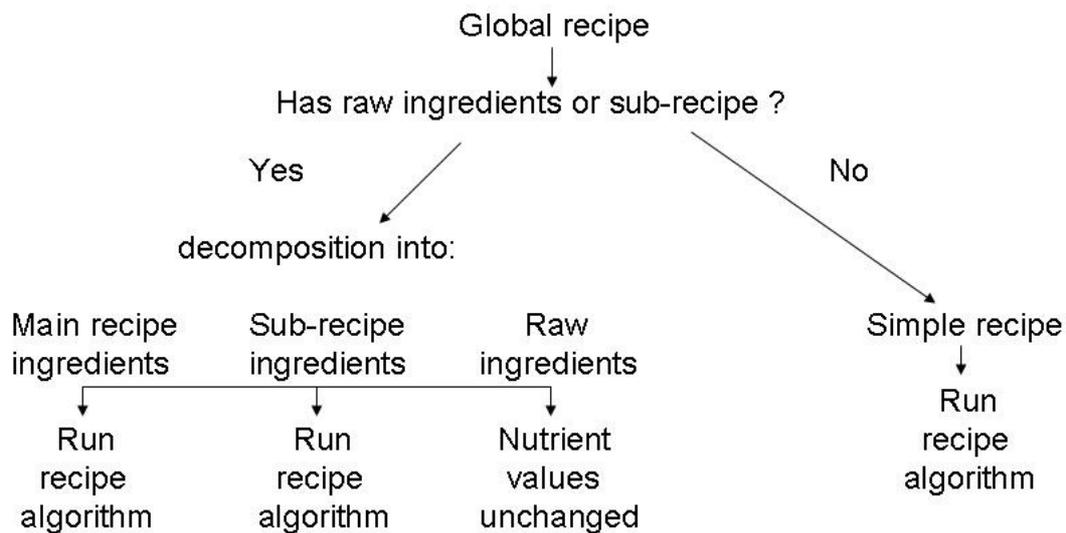
3.6 The method of Bognár and Piekarski

According to Bognár and Piekarski (2000) the information about edible portions, weight changes resulting from fat and water uptake or loss, and retention factors are required for recipe calculation. Both yield and retention factors are applied at recipe level. Nutrient retention of dishes consisting of several ingredients is assumed to be about the same as that of the main ingredient. The steps of this method are described in detail in section 3.5 of this report. Some exceptions should be taken into account when developing recipes.

Dry foods such as rice, pasta and legumes, gain weight during boiling due to water uptake. In this situation water quantities should be excluded from the recipe. Secondly, the amount of cooking fat in the recipe of fried or deep fried food should be the same quantity as the fat absorbed. Retention factor for the fat uptake during frying or deep frying of a food should not be used.

3.7 Method used in EPIC study

The European Prospective Investigation into Cancer and Nutrition (EPIC) studies diet, health and lifestyle in ten European countries. Project aims to develop a standardized EPIC Nutrient database (ENDB), which allows the calibration of dietary data from country-specific dietary questionnaires and pooled diet-disease analyses at the nutrient level. ENDB recipe calculation procedure applies retention factors at the ingredient level according to the ingredient group and the cooking method. Retention factors are applied to vitamins, whereas minerals are assumed to be 100% retained in recipes. Yield factors for water, fat and alcohol are applied at the recipe level.



This picture describes ENDB recipe calculation procedure. If recipe contains sub-recipes e.g. strawberry pie (short crust pastry, filled with custard, topped with raw strawberries), the procedure is run separately for the main recipe and the sub-recipe and then the results are summed up to 100 g of global recipe.

3.8 Food labelling regulation in EU

EU has directives on food labelling (90/496/EEC and 2000/13/EC), but there is no specific regulation or guidelines regarding recipe calculation. According to the EU regulation all ingredients of a foodstuff should be stated in descending order by weight on the food label. The indicated quantity shall correspond to the quantity of the ingredient at the time of its use in the manufacturing of the foodstuff. Added water and other volatile products are an exception; their quantity shall correspond to the weight in the finished product. The amount of water added as an ingredient in a foodstuff shall be calculated by deducting from the total amount of the finished product the total amount of the ingredients used. Thus, yield factor is applied only to fluids.

According to the EU regulation the stated nutrient contents shall relate to the foodstuff after preparation. However, no specific guidelines about the use of retention factors are given.

3.9 Comparison of commonly used methods

The previously presented recipe calculation procedures can be summarized according to the level at which yield and retention factors are taken into account (Table 1). The detailed calculation examples can be found in Appendix 2.

Table 1. Recipe calculation methods.

<i>Recipe calculation method</i>	<i>Yield factor</i>	<i>Retention factor</i>
INFOODS method	recipe level	ingredient level
British method	recipe level	ingredient level
Retention factor method	recipe level	ingredient level
Method used in EPIC	recipe level	ingredient level
Method of Bognár and Piekarski	recipe level	recipe level
Yield factor method	ingredient level	not applicable
EU labelling regulation	ingredient level*	not stated
Summing method	not applicable	not applicable

*applied only to fluids

4 Examples of recipe calculation applications in European food composition databases

4.1 Recipe calculation procedure used in NEVO database (the Netherlands)

In the NEVO database a recipe is calculated from its ingredients to get the nutritional values for the recipe. Recipes can be added to a new food without nutrient values from any other source. A recipe can also at any time be added to an existing food, with nutrient values from several other sources. As analytical values have a higher priority, the calculated values will in general be replaced by analytical values as soon as these are available.

A recipe is a number of food items (edible part) of a certain weight. The recipe calculation procedure is being used in three different situations:

1. To calculate nutrient content of a recipe from a cookbook
2. To calculate a weighted mean of a generic food based on several food items within a food group (for example pork meat with less than 5 gram of fat).
3. To calculate missing values e.g. individual fatty acids or specific micronutrients.

The following background information is recorded for each recipe: source of the information (name and edition of the cookbook), person who recorded or revised the recipe, purpose of adding the recipe (missing values; calculating generic food item), short description of differences between old and new data and date of recording or revision. Homemade recipes are based on the ingredients given in cookbooks and ingredients are recorded as the amount given in the cookbook. However, they are recorded as edible foods, so weight loss due to waste is taken into account before entering the weight of the ingredient. Recipes can be used as an ingredient of another recipe to a maximum of five levels. Cooked ingredients are used as ingredients, if available in the database. Herbs and

spices are not used as an ingredient when less than one gram is used. Recipes representing homemade foods are calculated without salt if possible, whereas recipes representing industrial foods are calculated with salt. Foods that are normally prepared and eaten with salt (soup, pastry, ready to eat processed foods) will have added salt in the database as well.

In the NEVO recipe calculation procedure both yield and retention factors are taken into account at recipe level. At present retention factors are used only for some bakery recipes because of the lack of knowledge on which retention factors to apply.

4.2 Recipe calculation procedure used in Slovakian food databank

Alimenta (formerly version 3, today version 4.2) software is used for recipe calculations in Slovakia. The software is able to store recipe tree, list of ingredients, weights of ingredients, id of ingredients, information on culinary treatments which is bound to applied retention factor, recipe id, and recipe name, composition of calculated portion and composition of 100 g of a dish. List of ingredients, recipe tree and information on culinary treatments are stored unless the database is exported to another installed software application. Then only composition of 100 g of calculated recipe without list of ingredients is available. All recipes can be used as ingredients to other recipes. Composition of all ingredients entering recipe is expressed per edible portion.

Retention factors (Bognár 2002) are applied at ingredient level automatically (by software) after a user selects particular culinary processes. Retention factors are applied on edible portions of ingredients and are available for following culinary treatments: roasting / grilling, boiling, stewing, braising, steaming, baking, and frying in pan. Some more treatments are given in the system (cleaning, wetting, grating / chopping, grinding, mixing, warming, blanching, pressure boiling pressure braising, deep frying and microwave boiling). However retention factors for them are missing. User is allowed to change, add

new or delete existing retention factors as well as change, add new or delete existing culinary treatments.

Retention factors are bound mostly to individual foods, only in some cases to complete food groups. Individual foods for which retention factors are available in the software are included in following food groups: meat (pork, beef, veal, lamb, mutton, goat), meat products, poultry (chicken, turkey, hen, duck, goose), poultry products, game (venison) and other animals, sea fish, freshwater fish, mollusks, crustaceans, grain, legumes, raw cereals, potatoes and potato products, fresh fruits, fresh vegetables (leafy, stalk, bulb, root, berrylike and leguminous).

Nutrients which can be affected by retention factors are proteins total, fat total, carbohydrates total, dietary fiber, minerals (ash), NaCl, sodium, potassium, calcium, magnesium, phosphorus, iron, copper, zinc, retinol equivalent, carotenoids (individual alpha, beta and gamma-carotenes), vitamin D, E, K, B₁, B₂, niacin, B₆, B₁₂, folic acid, pantothenic acid, biotin, vitamin C, lysine, methionine, cystine, organic acids, purines. For those foods where retention factor is equal 1 there is no evidence in software, though Bogнар’s publication provides this information.

Example of database on retention factors, where 082 is for boiling, 55260 is id of vitamin C and 471 is id for food group of raw potatoes.

NAME SK	NAME ENG	COMBINED CODE	RF
zemiaky	potatoes	08255260471*****	0.7

In case where 2 different culinary processes are chosen then two factors are applied one after another on particular nutrient content of an ingredient.

Although the software is designed for application of yield factors automatically; relevant database of yield factors is missing. Changes in losses and uptake of water and fat are

applied manually. This is performed the way that weight losses are corrected to whole recipe after retention factors were applied. It means that user should know weight of raw and cooked dish (e.g. from catering norms) or use a table of yield factors which is adopted from Bognár (2002) (most often tables 20, 21, 29 and 30 are used). In many cases recipes include information on dry matter content in cooked dish; this allows adjusting final proportion of water and dry matter in result. Sometimes similar recipe is used as a source of required information.

Uptake of fat, for example, during frying of foods is optional and user can use proportion according to his or her needs. Often even 50% of fat is considered as an uptake during frying, so related amount of fat is included in ingredients. Recipe composition is expressed both per 100 g of edible portion and per a given portion.

The main sources of recipes are officially approved school recipes (Actualized norms for school catering of the Slovak Republic, 2002) or special diet models (hospital canteens, homes for elderly, student residents) which usually meet recommendations of nutritionists and give portions in grams taking in account age and gender. Then minor part of recipes is provided by producers and cooking books. Part of recipe id, several digits, can be used as a reference code for a recipe source or literature.

Salt, spices and herbs are always included in recipe regardless the fact that these ingredients can be drained away in cooking water or their amount is insignificant. If whole food is to enter the recipe (e.g. meat with bones) user should recalculate weight of ingredient to edible portion. If cooked ingredient is available in the database it is used in recipe without application of retention factor.

Significant limitations in recipe calculation are missing values in some ingredients. More effort in future should be done in selection only those nutrients entering a final recipe composition for which data are available in all ingredients. Limitations are also in outdated

analytical data, so more actual analysis would be useful for more precise recipe calculation.

4.3 Recipe calculation procedure used in Iceland

Recipe calculations are carried out at the Icelandic Public Health Institute (PHI). The calculations are based on the Icelandic FCDB (ISGEM) from MATIS. The following is documented for each recipe at PHI: recipe number, recipe name, ingredient name and number (the same as in the Icelandic FCDB), weight of ingredient, total weight after cooking, % water loss, % fat loss and cooking method for each ingredient.

Yield factors are applied to the full recipe, whereas retention factors are applied to each ingredient. The retention factors used depend on the food group of the ingredient and the cooking method of the dish. For water used in a recipe, only the absorbed water is recorded as an ingredient. The calculation software (ICEFOOD) for nutrient and recipe calculations is originally from Denmark and further developed in Iceland to suit the local needs. The software is now old and new is needed.

The recipe calculations were initially made for the national nutrition survey carried out by the Icelandic Nutrition Council (now Public Health Institute). The recipe calculations have also been used in the Icelandic FCDB, especially for publication of food tables for schools, and for nutrition studies at the University of Iceland. Limitations of recipe calculations are the lack of nutrient data for ingredients in the Icelandic FCDB. More food analyses are needed.

4.4 Recipe calculation procedure used in Finnish food composition database

The recipes of homemade composite dishes are based on the most popular Finnish cookbooks. Ingredients of recipes are recorded as edible food (e.g. banana without peel). When a dish includes cooked ingredients (e.g. cooked rice in tuna salad), cooked

ingredients are used in recipes, if available in the food composition database. Salt used in recipes is always recorded as an ingredient.

If the recipe contains water which is poured off after cooking (e.g. boiled potatoes) only the amount of water that is supposedly absorbed by the potatoes is recorded as an ingredient. Also, if a food is fried or deep-fried (e.g. doughnut), only the absorbed amount of cooking fat is recorded as an ingredient.

In general for processed composite foods the recipe of a corresponding homemade dish is used. For research purposes, also the declared ingredient list of basic processed foods (e.g. breakfast cereal) can be recorded as a recipe, presuming that the ingredients are available in the food composition database. The amount of an ingredient is approximated, if it is not declared on the label.

Both yield and retention factors together are applied at ingredient level. Only yield factor for water is taken into account. The retention factor used depends on the food group of the ingredient and the cooking method of the dish. For example the same retention factor is used for all milk products when the dish is prepared in the same way. Composite dishes can also be used as an ingredient of another recipe. In these cases retention factors are applied only once.

4.5 Recipe calculation procedure used in the German Nutrient Database (BLS)

The BLS uses recipes provided by the German Nutrition Society (DGE) and from German cookbooks. The Database contains research results of the German Federal Research Centres for Nutrition and Food (BfEL) and of other national partners, such as universities, national research agencies, regional offices, private institutes, and professional associations. In addition, analytical values compiled from nutritional science literature, international nutrient tables and from food companies are qualitatively evaluated before being adopted.

All this data and their sources are documented in an unpublished data file. For the analytical data included in the BLS, national nutrient data were preferably chosen. The analyzed data correspond mostly to unprocessed food items. In order to obtain the nutrient values for composite dishes and processed food as well, methods of calculation were developed. That means that nutritional data in the BLS were mainly generated by algorithms and model calculations.

The BLS software has been programmed in a very flexible way. It has both a combination of recipe calculation at recipe level and recipe calculation at ingredient level.

These procedures are explained as follows:

1. The BLS has a mix file, where food items are a result of the mix of individual ingredients undergoing an industrial process (deep frozen, heated, dried etc.). Here the calculation is made at the recipe level as follows:

- Sum the amount of nutrient X of all ingredients
- Correct this value for weight loss and nutrient retention

2. The BLS also has a recipe file, where food items undergo a household preparation procedure (boil, fry, grill, bake, etc). Here the calculation is made at the ingredient level as follows:

- Select the raw ingredients for the recipe
- Correct the amount of nutrient X of each ingredient using the corresponding weight yield and the corresponding retention factor.

4.6 Recipe calculation procedure used in Israel, BGU

The Israeli food composition databank is based on the USDA data, which is adapted to suit the Israeli diet (Shai, Vardi et al. 2003). Changes were made to US recipes that contain ingredients not used in Israel e.g. lard (for religious reasons). The nutrient content of local foods that are not found in the USDA databank had to be calculated, because laboratory analysis of foods is not an option at the moment. Nutrient values of foods were also obtained direct from manufacturers or from nutrition labels of manufactured foods. Recipes for local foods were taken from 14 popular Israeli cookbooks or were obtained in field interviews. In the calculation procedure both yield and retention factors are taken into account. Software is used in the recipe calculation.

1. Select or develop a recipe.
2. Determine the ingredient weights (computer program converts volume to weight in grams).
3. Calculate the retention factor for each ingredient.
4. Calculate the percentages of moisture loss and fat absorption.
5. Determine the portion size.

4.7 Summary of recipe calculation applications used in European food composition databases

The previously presented recipe calculation procedures can be summarized according to the level at which yield and retention factors are taken into account (Table 4). The selection of these databases was based on the trend report (Ovaskainen, Krines et al. 2005). The detailed calculation examples can be found in Appendix 2.

Table 4. Examples of recipe calculation methods in Europe.

<i>Recipe calculation method</i>	<i>Yield factor</i>	<i>Retention factor</i>
Slovak database	recipe level	ingredient level
Israeli database	recipe level	ingredient level
Icelandic database	recipe level	ingredient level
NEVO database	recipe level	recipe level
German Nutrient database*	recipe and ingredient level	recipe and ingredient level
Finnish food composition database	ingredient level	ingredient level

*flexible, recipe calculation possible both at recipe and ingredient level

The methods used in Israeli, Slovak and Icelandic databases correspond to the INFOODS, British and Retention factor methods, whereas the method used NEVO and partly in Germany databases correspond to the method of Bognár and Piekarski. The calculation of yields at ingredient level used in Finland and partly in Germany databases correspond to the Yield factor method.

5 Key issues in recipe calculation

The key issue in recipe calculation is at which level, ingredient or recipe, yield and retention factors are taken into account: In following theoretical examples these different procedures are compared. More detailed calculations can be found in Appendix 2.

The compared procedures are following:

Procedure a, which takes both yield and retention factor into account at recipe level.

Procedure b which takes the yield factor into account at recipe level and the retention factor into account at ingredient level.

Procedure c which takes both yield and retention factor into account at ingredient level.

Table 5. Comparison of different recipe calculation procedures.

	procedure a	procedure b	procedure c
raw weight g	2505	2505	2505
cooked weight g	2255	2255	2405
nutrient X mg per 100 g of cooked weight before retention factor is taken into account	16.6	16.6	15.6
nutrient X mg per 100 g of cooked weight after retention factor is taken into account	11.6	12.6	11.9

a) Both yield and retention factors at recipe level

b) Yield factor at recipe level and retention factor at ingredient level

c) Both yield and retention factors at ingredient level

Recipe calculation procedures a and b apply yield factor at recipe level. This means that water supposedly evaporates equally or fat is dripped off equally from all ingredients; even if their water or fat content is almost zero (e.g. table salt). This leads also to a lower total cooked weight and a higher nutrient density compared to the respective results of the procedure c (see table 5). Nonetheless, effect is cumulative. For example, in the last row of table 5, when retention factor is taken into account, there are small differences between the procedures. However, because the presented calculation is based on only one recipe, it cannot be said if these differences in nutrient content are significant or not.

The second issue is what factors are suitable for the recipe in question. For example at ingredient level, the weight loss of each ingredient must be estimated, whereas at recipe level the weight loss of the whole dish can be measured. Recipes with multiple preparation phases are the most problematic regarding nutrient retention and yield factors. What would be the most appropriate retention factor for meat in lasagne, which is first fried and then baked in an oven? Or how to handle water, fat or salt in recipes where the cooking

medium is discarded after cooking? Retention and yield factors are discussed in detail in a report prepared by work package 1.8 (Bell 2006).

The third issue is the training of compilers on recipe calculation. When preparing this report, we found out that compilers can have difficulties in describing their recipe calculation procedure. It seems that it is not uncommon for IT persons having taken the responsibility for the recipe calculation procedures. Also the use of terms, such as yield and retention factor, can be confusing. It should also be kept in mind that water can be both an ingredient and a nutrient. Therefore both weight and water as a nutrient value should be adjusted, when a cooked dish has water as an ingredient.

A particular question compilers have to deal with is how to treat processed foods. All food composition databases include also processed foods (Ovaskainen, Krines et al. 2005). If no analyzed nutrient values are available for processed foods they are treated like home-made foods in recipe calculation procedures in food composition databases. However, industrial processes differ significantly from cooking methods used at home and therefore the nutrient retention factors used when calculating nutrient content of processed foods should be specific to industrial processes. At the moment there is very little information available on what retention factors could be used for processed foods (e.g. Athar, Hardacre et al. 2006), or what retention factors the food industry is using when calculating nutrient values for food labelling purposes. Also, it is not known to what extent the recipe calculation and yield and retention factors are used by the food industry. Generally, it could be assumed that recipe calculation is used mostly in small and medium-sized enterprises, which probably have not enough resources for food analysis.

6 A proposal for recipe calculation procedure for EuroFIR partners

To simplify it, there are basically two procedures for recipe calculation: applying the yield and retention factors at recipe or ingredient level. The difference between these methods is not great presuming that compilers use the same harmonized yield and nutrient retention factors. However, the best method must be approved later experimentally. It cannot be determined which method is the most accurate without validation studies where values calculated using different methods are compared with analytical values. There have been studies looking at the differences between different databases used in the conversion of food intakes into nutrient intakes (Deharveng, Charrondière et al. 1999; Hakala, Knuts et al. 2003; Vaask, Pomerleau et al. 2004; Hjartaker 2007), but so far there are only few studies directly comparing calculated nutrient values with values produced by analysis (Vasilopoulou, Georga et al. 2003). Such a validation study could perhaps be conducted within EuroFIR incorporated into analytical work already planned in work package 2.3.1 Traditional foods or work package 2.3.2 Ethnic foods.

The basis of recipe calculation is standardized retention factors, which are given by work package 1.8. In addition to the standardized factors, the description of parameters (e.g. cooking method) which affect these factors will be standardized.

It should be borne in mind that analysis is always the preferred method to determine the nutrient content of foods. Rand and Pennington et al (1991) stress that calculation produces estimates of nutrient content of composite foods and results should always be regarded as approximations. Recipe calculation is however, a necessary and invaluable tool to produce nutrient values when analysis is not possible. Even if analysis of composite foods is not feasible it is important to have analyzed values for the nutrient contents of basic foods in the FCDBs since these are the basis for calculated nutrient contents of composite foods. Differences between analyzed and calculated values can be due to the differences in the nutrient content of ingredients in the FCDB and ingredients actually used in food preparation (Vasilopoulou, Georga et al. 2003).

The scale of the difference between the different recipe calculation procedures can be questioned when compared to the possible sources of error when collecting data on food consumption. Recipes in the FCDBs might differ significantly from those actually consumed by study subjects. Each collection method has its own sources of error such as under-reporting when using food diaries and reliance on memory in 24-h food recall. However, it is not possible to address these issues in this report or even compare the scale of errors between different recipe calculation methods and those associated with food consumption studies. Although it is good to bear in mind the big picture, these issues are separate from the recipe calculation procedure.

The proposal for a harmonized recipe calculation procedure was discussed at Compiler Network meeting in Paris 2007. It was noted that without analytical values of dishes, it is impossible to decide which one of the recipe calculation procedures is the best. It was also estimated that there is more difference between calculated and analysed values than between calculation methods. Therefore it was decided to select the most commonly used recipe calculation procedure, which applies yield factor at recipe level and retention factors at ingredient level. In addition, it was decided that every partner currently using recipe calculation, should document their calculation system.

The EuroFIR recipe calculation procedure applies yield factor at recipe level and ingredient factors at ingredient level.

7 Future challenges

This report focused solely on recipe calculation procedures, further applications like softwares will be future challenges for EuroFIR. Also, this report serves as a starting point to the work packages 1.8 and 2.2 in preparing the XML food transport package. However, it is beyond the scope of this report whether compilers have the personnel and monetary resources to change the recipe calculation procedure that is currently used in their database, or whether a change is even possible e.g. from a software point of view. It is, however, recommended that partners not currently calculating nutrient values in their databases could opt to use the procedure recommended in this report.

Training on recipe calculation procedure is needed among EuroFIR partners. Terminology is not clear and documentation of used recipe calculation system has been left on responsibility of IT persons. Training on how to communicate with IT specialist is important as well. Both in the case that IT is taking care of the calculation procedure and in the case that compilers and IT work together closely this needs attention to prevent mistakes. Also, the algorithms for the calculation procedure need to be provided for software developers. In addition, from a quality point of view training is needed and recipe calculation guidelines should be included in standard operating procedures (SOPs).

Besides compilers, recipe calculation is needed by different stakeholders. Food industry, especially SMEs, use recipe calculation procedure for labelling purposes. Researchers and dieticians need recipe calculation for dietary intake assessment, because in some cases dietary intake can not be calculated accurately enough by using standard recipes. Hence there is also a need for recipe calculation guidelines for both labelling purposes and for maintaining user databases.

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9 Appendix 1. The EuroFIR compilation process for recipe calculation

1. Collect recipes

Use the most sold standard cookbooks or the most popular recipe archives on the websites. If you use recipes from the website, don't forget to print out the recipe. If no written recipes are available (e.g. ethnic or traditional foods), conduct the field work.

2. Determine ingredient weights

Convert household measures to gram weights. If the weight of ingredient includes inedible waste (e.g. banana with peel), correct the weight of ingredient to the edible weight.

3. Sum weights of raw ingredients.

4. Correct the weight for effect of cooking by applying yield factor to the total raw weight.

Total cooked weight g = total raw weight g * yield factor

5. Calculate the nutrient values

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g / total cooked weight g

6. Correct the nutrient values for effect of cooking

Apply the appropriate retention factors at ingredient level. Adjust also the nutrient values for water, alcohol and fat, if they are lost or gained during cooking. The standardised retention factors will be provided by work package 1.8.

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g * retention factor / total cooked weight g

7. Documentation

Document the used sources for recipes (e.g. cookbooks) and for yield and retention factors.

10 Appendix 2. Examples of recipe calculation procedures

10.1 Procedure a) yield factor at recipe level and retention factor at recipe level

Sum weights of raw ingredients. Apply yield factor (0.90) to the total raw weight.

Ingredient	raw weight g	yield factor	cooked weight g
cabbage	1000		
carrot	500		
water	1000		
table salt	5		
Total weight g	2505	0.90	2255

Total cooked weight g = total raw weight g * yield factor = 2505 g * 0.90 = 2255 g

Calculate the nutrient content of cooked dish. Apply retention factor (0.70) to the nutrient content.

Nutrient content per 100 g ingredient	
Ingredient	Nutrient x µg
cabbage	30
carrot	15
water	0
table salt	0

Ingredient	nutrient X µg per 100 g of cooked weight before retention factor is taken into account	retention factor	nutrient X µg per 100 g of cooked weight after retention factor is taken into account
cabbage	13	0.70	9
carrot	3.3	0.70	2.3
water	0	0.70	0
table salt	0	0.70	0
Total nutrient x µg	16.6		11.6

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g / total cooked weight g

For example cabbage: $30 \mu\text{g} * 1000 \text{ g} / 2255 \text{ g} = 13 \mu\text{g}$

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g * retention factor / total cooked weight g

For example cabbage: $30 \mu\text{g} * 1000 \text{ g} * 0.70 / 2255 \text{ g} = 9 \mu\text{g}$

10.2 Procedure b) yield factor at recipe level and retention factor at ingredient level

Sum weights of raw ingredients. Apply yield factor (0.90) to the total raw weight.

Ingredient	raw weight g	yield factor	cooked weight g
cabbage	1000		
carrot	500		
water	1000		
table salt	5		
Total weight g	2505	0.90	2255

Total cooked weight g = total raw weight g * yield factor = 2505 g * 0.90 = 2255 g

Calculate the nutrient content of cooked dish. Apply retention factor (0.70) to the nutrient x content of cabbage. Use the retention factor 1.00 for other ingredients.

Nutrient content per 100 g ingredient	
Ingredient	Nutrient X µg
cabbage	30
carrot	15
water	0
table salt	0

Ingredient	nutrient X µg per 100 g of cooked weight before retention factor is taken into account	retention factor	nutrient X µg per 100 g of cooked weight after retention factor is taken into account
cabbage	13	0.70	9
carrot	3.3	1.00	3.3
water	0	1.00	0
table salt	0	1.00	0
Total nutrient X µg	16.6		12.6

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g / total cooked weight g

For example cabbage: $30 \mu\text{g} * 1000 \text{ g} / 2255 \text{ g} = 13 \mu\text{g}$

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g * retention factor / total cooked weight g

For example cabbage: $30 \mu\text{g} * 1000 \text{ g} * 0.70 / 2255 \text{ g} = 9 \mu\text{g}$

10.3 Procedure c) yield factor at ingredient level and retention factor at ingredient level

Sum weights of raw ingredients. Apply yield factor (0.90) to the raw weight of water. Use yield factor 1.00 for other ingredients. Sum weights of cooked ingredients.

Ingredient	raw weight g	yield factor	cooked weight g
cabbage	1000	1,00	1000
carrot	500	1,00	500
water	1000	0,90	900
salt	5	1,00	5
Total weight g	2505		2405

Cooked weight g = raw weight g * yield factor

For example water: $1000 \text{ g} * 0.90 = 900 \text{ g}$

Calculate the nutrient content of cooked dish. Apply retention factor (0.70) to the nutrient x content of cabbage. Use the retention factor 1.00 for other ingredients.

Nutrient content per 100 g ingredient	
Ingredient	Nutrient x μg
cabbage	30
carrot	15
water	0
salt	0

Ingredient	nutrient X µg per 100 g of cooked weight before retention factor is taken into account	retention factor	nutrient X µg per 100 g of cooked weight after retention factor is taken into account
cabbage	12	0.70	9
carrot	3.1	1.00	3.1
water	0	1.00	0
salt	0	1.00	0
Total nutrient x µg	15.6		11.9

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g / total cooked weight g

For example cabbage: $30 \mu\text{g} * 1000 \text{ g} / 2405 \text{ g} = 12 \mu\text{g}$

Nutrient content per 100 g of cooked weight = nutrient content of ingredient * raw weight of ingredient g * retention factor / total cooked weight g

For example cabbage: $30 \mu\text{g} * 1000 \text{ g} * 0.70 / 2405 \text{ g} = 9 \mu\text{g}$