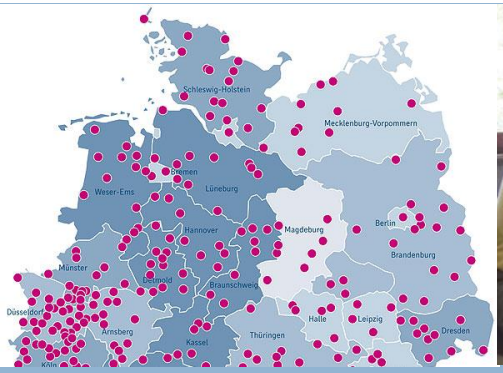
MRI
Max Rubner-Institut





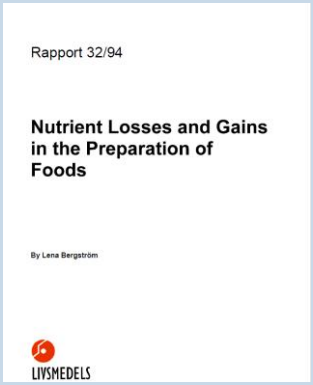


Introduction of the „Comprehensive European Recipe Calculation Guideline“

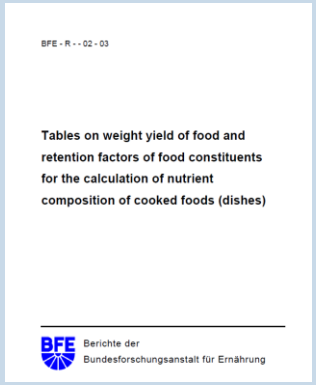
Katja Sandfuchs
Nicole Fark
Susanne Westenbrink
Mark Roe
Karl Presser
Bernd Hartmann

Introduction

Milestones in recipe calculation:

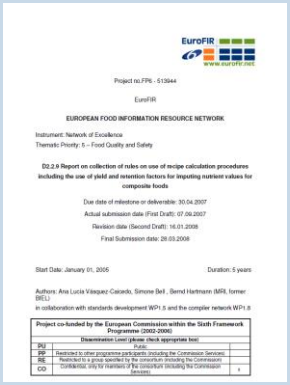


Bergström, 1994



Bognar, 2002

EuroFIR achievments to harmonise recipe calculation:



Vasquez-Caicedo et al. 2008



Reinivuo et al. 2009



Machackova et al. 2017

The aim of the following guideline is ...
… to combine achievements of EuroFIR and Bognar
… to provide a comprehensive, step-by-step, user-friendly manual addressed to compilers of a Food Composition Database

→ Today, we want to introduce the guideline, answer questions, start discussions, get feedback

Definitions

Weight Yield Factor (WYF)

The weight yield factor represents the amount of **weight change** of a dish.

Determination through **cooking experiments**.

In the recipe calculation, the WYF is applied at **recipe level**.

WYFs > 0

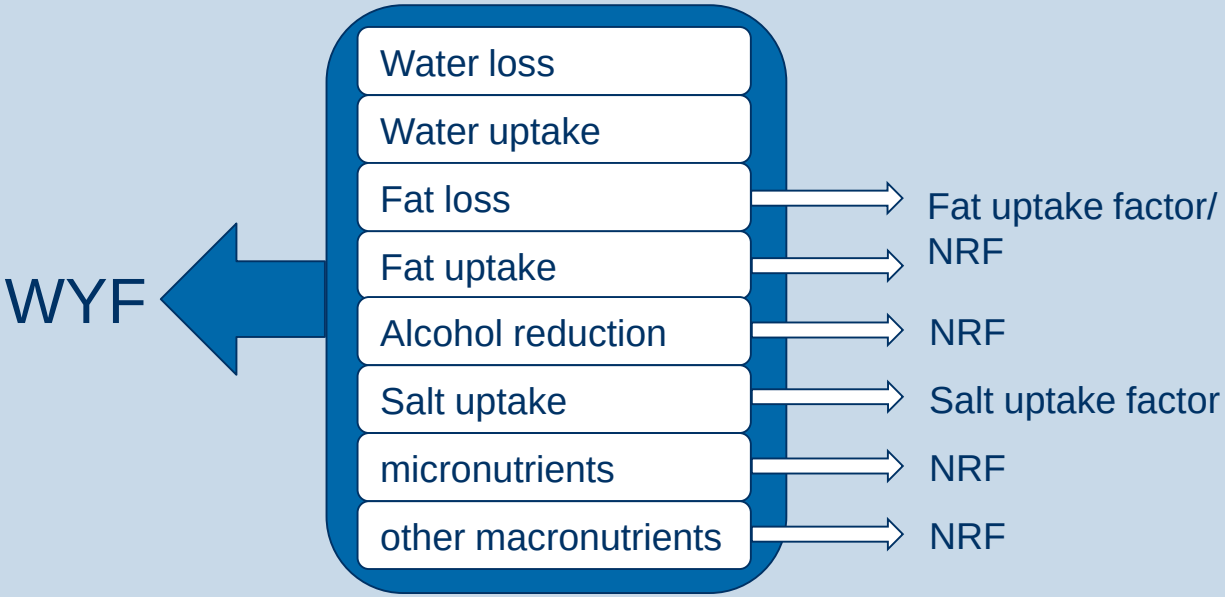
Nutrient Retention Factor (NRF)

The nutrient retention factor represents the **change in nutrient content**.

Determination trough **cooking experiments and laboratory analysis.**

In the recipe calculation, the NRF is applied at **ingredient level.**

NRFs ≤ 1.0



Overview

Step 1:	Collection of recipe information
Step 2:	Determination of weight of ingredients (ready-to-cook-state)
Additional steps:	Determination of fat and salt uptake
Step 3:	Determination of weight of dish (with WYF)
Step 4:	Determination of nutrient data of ingredients
Step 5:	Calculation of nutrient content of each ingredient per 100g dish (without NRF)
Step 6:	Assigning of NRF
Step 7:	Calculation of nutrient content of each ingredient per 100g dish (with NRF)
Step 8:	Calculation of water content

Step 1: Collection of recipe information (1)

Dish name: **Apple pie**

Cooking method: Baking

Cooking temperature: 180-200 ° C

Cooking time: 45 minutes

Reference: Bayerisches Kochbuch (Hofmann and Lydtin 2007)

Ingredients:

ingredient	Amount of ingredient
Wheat flour (type 405)	250 g
Chicken egg	3 eggs
Sugar white	150 g
butter	150 g
Apple, peeled	750 g
Cow‘s milk 3.5 % fat	4 tbsp.
Baking powder	2 tsp.
Lemon peel	of half a lemon

Edible conversion factor

Conversion of household measures

Conversion of household measures

Preparation description: Whisk the butter until frothy. Add sugar and eggs and whisk again. Add the lemon peel. Mix wheat flour and baking powder and stir in with milk to the dough. Put the dough on a baking tray. Cut apples in pieces and place on top of the dough. Bake the cake for 45 minutes (180-200 C).

Step 1: Collection of recipe information (2)

Step 1: Collection of recipe information

Ingredients	amount
Ingredient 1, raw	
Ingredient 2, raw	
Ingredient 3, raw	

Step 2: Determination of weight of ingredients (ready-to-cook-state) (1)

Conversion of household measures

Household measures in recipes must be transferred to weight measures.

Example:

3 eggs = 189 g (1 egg with shell = 63 g (Dinauer et al. 1991))

Correction for waste

The amount of ingredients in the recipe should be corrected for waste via edible conversion factors.

$$\text{weight of the raw ingredient (edible part)(g)} = \text{weight of the ingredient (with waste)(g)} \times \text{edible conversion factor}$$

Example:

Edible conversion factor of raw chicken egg = 0,87 (Finglas *et al.*, 2015):

→ *Weight of chicken egg (edible part) (g)= 63 g x 0,87 = 55 g*

Step 2: Determination of weight of ingredients (ready-to-cook-state) (2)

Additional step:

Fat uptake

Fat uptake factor defines the amount of cooking fat, which is taken up, per 100g of all ingredients (Unit g/100g).

$$\text{fat uptake in recipe (g)} = \text{sum of ingredients (g)} \times \text{fat uptake factor}$$

Example:

Fat uptake of breaded, fried pork liver

Ingredient	Weight of ingredient, edible part (g)
4 slices of pork liver (each 125 g)	500
Wheat flour (Type 405)	10
Rapseed oil	**20.4**
Total weight of raw ingredients	**530.4**

fat uptake factor for fried breaded liver is 4 g/ 100 g (Bognar, 2002)

→ *Fat uptake of breaded, fried liver (g) = 510 g x 4 g/ 100g = 20.4 g*

The NRF for the fat content of all ingredients has to be 1.0!

Step 2: Determination of weight of ingredients (ready-to-cook-state) (3)

Additional step:

Cooking salt uptake

Cooking salt uptake factor defines the amount of cooking salt, which is taken up out oft the cooking medium (salt uptake factors ≤ 1.0).

$$\text{cooking salt uptake (in recipe)(g)} = \text{added cooking salt (g)} \times \text{cooking salt uptake factor}$$

Example:

Uptake of cooking salt out of the cooking medium water by boiling pasta

Ingredient	Weight of ingredient, edible part (g)
Pasta (spaghetti)	400
Cooking salt	**3.0**
Total weight of raw ingredients	**403**

20 g cooking salt (1tsp. = 5 g) were added to the cooking medium water

Cooking salt uptake factor is 0.15 (cereal flour based dishes) (Bognar, 2002)

→ *Cooking salt uptake (g) = 20 g x 0.15 = 3.0 g*

The NRF of each mineral for cooking salt will be 1.0!

Step 2: Determination of weight of ingredients (ready-to-cook-state) (4)

Step 1: Collection of recipe information

Step 2: Determination of weight of ingredients (ready-to-cook-state)

Ingredients	amount
Ingredient 1, raw	X g
Ingredient 2, raw	X g
Ingredient 3, raw	X g
Fat uptake	X g
Cooking salt uptake	X g

Total weight of raw ingredients	X g

Step 3: Determination of weight of the dish (1)

The WYF defines the weight change during cooking, which is caused mainly through water increase, water reduction, fat uptake, fat loss, alcohol reduction and salt uptake.

$$\text{Weight of prepared dish (g)} = \text{total quantity of ingredients (ready-to-cook) without cooking medium (water, fat) (g)} \times \text{WYF}$$

Example:

Calculation of weight of boiled pasta (spaghetti)

Ingredient	Weight of ingredient, edible part (g)
Pasta (spaghetti)	400
Cooking salt	3.0
Total weight of raw ingredients	403.0
Weight of boiled pasta	1003.5



WYF = 2.49 (average value) (Bergström, 1994, Bognar, 2002, Finglas *et al.*, 2015))

→ *Weight of boiled pasta (g) = 403 g x 2.49 = 1003.5 g*

Step 3: Determination of weight of dish (with WYF) (2)

Step 1: Collection of recipe information

Step 2: Determination of weight of ingredients (ready-to-cook-state)

Ingredients	amount
Ingredient 1, raw	X g
Ingredient 2, raw	X g
Ingredient 3, raw	X g
Fat uptake	X g
Cooking salt uptake	X g

Total weight of raw ingredients	X g
Weight of cooked ingredients	X g

WYF

Step 3: Determination of weight of dish (with WYF)

Step 4: Determination of nutrient data of ingredients (1)

The nutrient content per 100g ingredient out of a FCDB has to be used in the calculations for every nutrient.

SBLS	ST	GCAL	GJ	GCALZB	GJZB	ZW	ZE	ZF	ZK	ZB	ZM	ZO	ZA	VA	VAR	VAC	VD	VE	VEAT	VK	VB1	VB2	VB3	VB3A	VB5	VB6	VB7	VB9G
F110000	Apfel	61	255	65	271	82471	340	49	14350	2010	320	460	0	5	0	29	0	490	490	6	11	9	300	350	100	43	5	5
F110100	Apfel roh	61	255	65	271	82470	340	49	14350	2010	320	460	0	5	0	29	0	490	490	6	11	9	300	333	100	43	5	5
F110101	Apfel roh mit Küchenabfall	56	234	59	249	75874	313	45	13202	1849	294	423	0	5	0	26	0	451	451	5	10	8	276	326	92	40	4,6	5
F110122	Apfel gegart	61	254	65	271	82535	369	54	14361	2012	285	384	0	4	0	24	0	545	545	6	9	9	284	334	95	38	5,6	3
F110132	Apfel gekocht	55	231	59	245	84243	367	56	13030	1825	218	261	0	4	0	24	0	556	556	6	8	8	272	322	91	34	5,7	3
F110162	Apfel gebacken	66	277	70	295	80895	371	53	15640	2191	349	501	0	5	0	28	0	534	534	6	10	9	294	344	109	45	5,4	3
F110172	Apfel gegrillt	70	291	74	309	79996	388	56	16376	2294	365	525	0	5	0	28	0	559	559	6	10	10	308	358	114	47	5,7	3
F110182	Apfel gebraten (zubereitet ohne Fett)	64	266	67	282	81717	355	51	14967	2096	334	480	0	4	0	22	0	511	511	6	9	8	282	332	104	40	5,2	3
F110200	Apfel tiefgefroren	64	266	67	282	81717	355	51	14967	2096	334	480	0	5	0	27	0	460	460	5	10	8	282	332	94	40	4,7	5
F110300	Apfel Konzentrat	265	1109	265	1109	32000	1653	210	61994	0	1658	2485	0	26	0	149	0	2515	2515	31	46	41	1458	1708	488	210	24	26
F110400	Apfel getrocknet	247	1035	269	1125	26812	1370	1628	55400	11230	1460	2100	0	18	0	91	0	1566	1566	18	100	100	800	1000	274	119	14	14
F110462	Apfel getrocknet gebacken	254	1064	276	1156	24796	1408	1673	56926	11539	1500	2158	0	17	0	84	0	1609	1609	18	82	98	740	973	282	116	14,4	9
F110600	Apfel Fruchtsaft (Ohne Zuckerzusatz)	57	239	57	239	85293	316	41	13357	0	317	476	200	5	0	29	0	507	507	6	9	7	249	299	83	36	4	3
F110700	Apfel Fruchtnektar	69	287	69	287	82732	158	21	16676	0	171	238	0	3	0	15	0	254	254	3	5	4	119	152	40	17	1,9	2
F110800	Apfel Konfitüre	262	1096	263	1101	34592	125	18	64200	741	130	169	0	1	0	6	0	91	91	1	1	1	33	50	11	5	0,5	0
F110900	Apfel Konserve, nicht abgetropft	89	372	91	380	76735	184	26	21500	1107	181	261	0	3	0	16	0	278	278	3	5	4	128	145	42	18	2,2	2
F110902	Apfel Konserve abgetropft	88	368	91	382	76174	285	40	21026	1804	236	425	0	5	0	25	0	453	453	5	5	4	136	169	44	19	2,3	1
F110922	Apfel Konserve abgetropft gegart	88	368	91	382	76227	309	44	21040	1805	210	354	0	4	0	21	0	504	504	6	4	4	129	162	42	17	2,6	1
F110942	Apfel Konserve abgetropft geschmort (zubereitet ohne Fett)	95	398	99	414	74210	308	43	22760	1953	255	460	0	4	0	20	0	490	490	5	4	4	132	165	43	19	2,5	1
F112600	Apfel Fruchtsaft angereichert mit Vitamin C	57	239	57	239	85293	316	41	13357	0	317	476	200	5	0	29	0	507	507	6	9	7	249	299	83	36	4	3
F115600	Apfel Fruchtsaft	47	197	47	197	87949	70	40	11060	0	270	470	140	8	0	45	0	501	501	0	20	25	300	317	55	96	1	8
F116600	Apfel Fruchtnektar mit Süßstoff	29	120	29	120	92620	158	21	6679	0	184	238	100	3	0	15	0	254	254	3	5	4	125	158	42	18	2	2
F119900	Apfel Konserve ungesüßt, nicht abgetropft	37	153	39	163	89426	209	35	8562	1220	199	349	0	3	0	17	0	311	311	3	5	5	142	159	49	21	2,4	2
F119902	Apfel Konserve ungesüßt abgetropft	34	143	38	158	89332	298	50	7722	1834	239	525	0	4	0	24	0	468	468	5	5	5	139	156	48	21	2,3	1
F119932	Apfel Konserve ungesüßt abgetropft gekocht	31	128	34	141	90556	319	56	6958	1653	162	296	0	3	0	20	0	527	527	6	4	5	125	142	43	17	2,6	1
F120000	Apfel geschält	55	232	59	246	84307	300	400	12400	1800	293	500	0	3	0	17	0	270	270	3	30	20	100	150	1	50	1,1	7
F120100	Apfel geschält roh	55	232	59	246	84307	300	400	12400	1800	293	500	0	3	0	17	0	270	270	3	30	20	100	150	1	50	1,1	7
F120101	Apfel geschält roh mit Küchenabfall	53	220	56	234	80092	285	380	11780	1710	278	475	0	3	0	16	0	257	257	3	29	19	95	145	1	48	1	7
F120122	Apfel geschält gegart	56	233	59	247	84345	325	445	12406	1801	261	417	0	3	0	14	0	300	300	3	24	19	94	144	1	44	1,2	5
F120162	Apfel geschält gebacken	60	253	64	269	82861	328	437	13542	1966	320	546	0	3	0	17	0	295	295	3	26	21	98	148	1	52	1,2	5
F120182	Apfel geschält gebraten (zubereitet ohne Fett)	58	242	61	257	83616	313	418	12946	1879	306	522	0	2	0	13	0	282	282	3	25	19	94	144	1	47	1,1	4
F120192	Apfel geschält frittiert (zubereitet ohne Fett)	58	242	61	257	83616	313	418	12946	1879	306	522	0	2	0	13	0	282	282	3	25	19	94	144	1	47	1,1	4
F120200	Apfel geschält tiefgefroren	58	242	61	257	83616	313	418	12946	1879	306	522	0	3	0	16	0	254	254	3	28	19	94	144	1	47	1	7
F120300	Apfel geschält Konzentrat	269	1127	269	1127	31999	1624	1929	59744	0	1693	3011	0	17	0	98	0	1543	1543	17	144	98	541	824	6	271	6	40
F120400	Apfel geschält getrocknet	282	1182	300	1255	19999	1530	2040	63238	9179	1464	2550	0	10	0	61	0	964	964	10	92	61	306	556	5	153	4	20
F120800	Apfel geschält Konfitüre	276	1157	278	1162	31137	111	147	67600	663	133	184	0	1	0	3	0	50	50	1	3	2	11	28	0	5	0,1	0

Extract of BLS 3.02

MRI, 2014

Step 4: Determination of nutrient data of ingredients (2)

Step 1: Collection of recipe information

Step 2: Determination of weight of ingredients (ready-to-cook-state)

Step 4: Determination of nutrient data of ingredients

Ingredients	amount
Ingredient 1, raw	X g
Ingredient 2, raw	X g
Ingredient 3, raw	X g
Fat uptake	X g
Cooking salt uptake	X g

Nutrient content per 100 g ingredient

Total weight of raw ingredients	X g
Weight of cooked ingredients	X g

Step 3: Determination of weight of dish (with WYF)

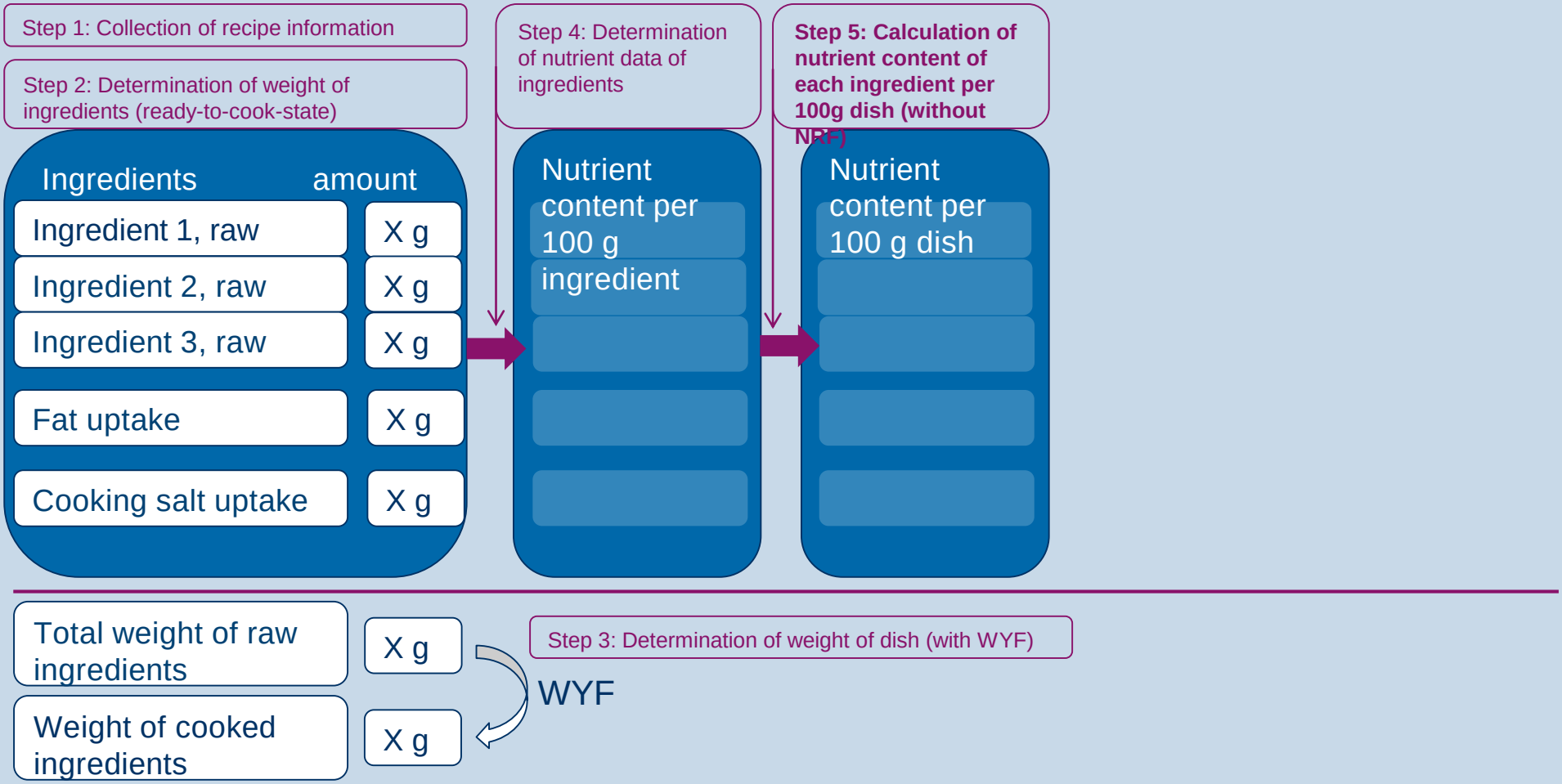
WYF

Step 5: Calculation of nutrient content of each ingredient per 100g dish (without NRF) (1)

Formula, to calculate the contribution of each ingredient and each corresponding component to 100g of cooked weight, before the NRF is taken into account.

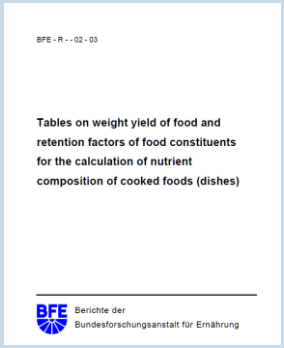
$$\text{Nutrient content of ingredient X per 100 g dish (without NRF)} = \frac{\text{nutrient content per 100 g ingredient} \times \text{raw weight of ingredient (g)}}{\text{weight of prepared dish (g)}}$$

Step 5: Calculation of nutrient content of each ing. per 100 g dish (wo NRF)

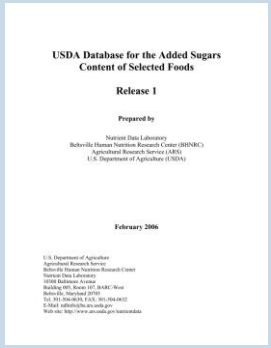


Step 6: Assigning of NRF (1)

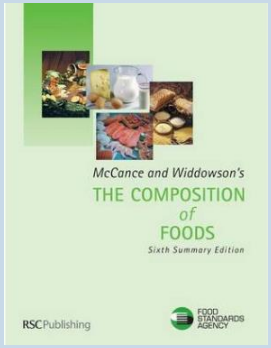
NRFs for micronutrients



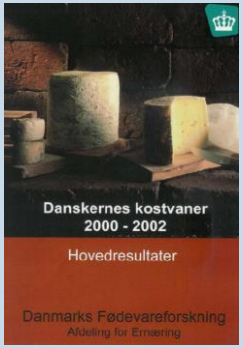
Bognar, 2002



USDA, 2003

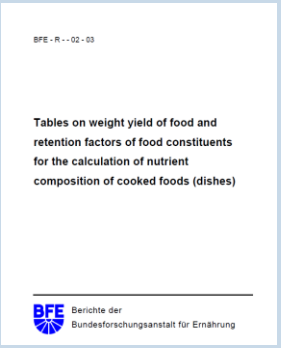


Foods Standards Agency, 2002



DTU, 2005

NRFs for macronutrients



Bognar, 2002

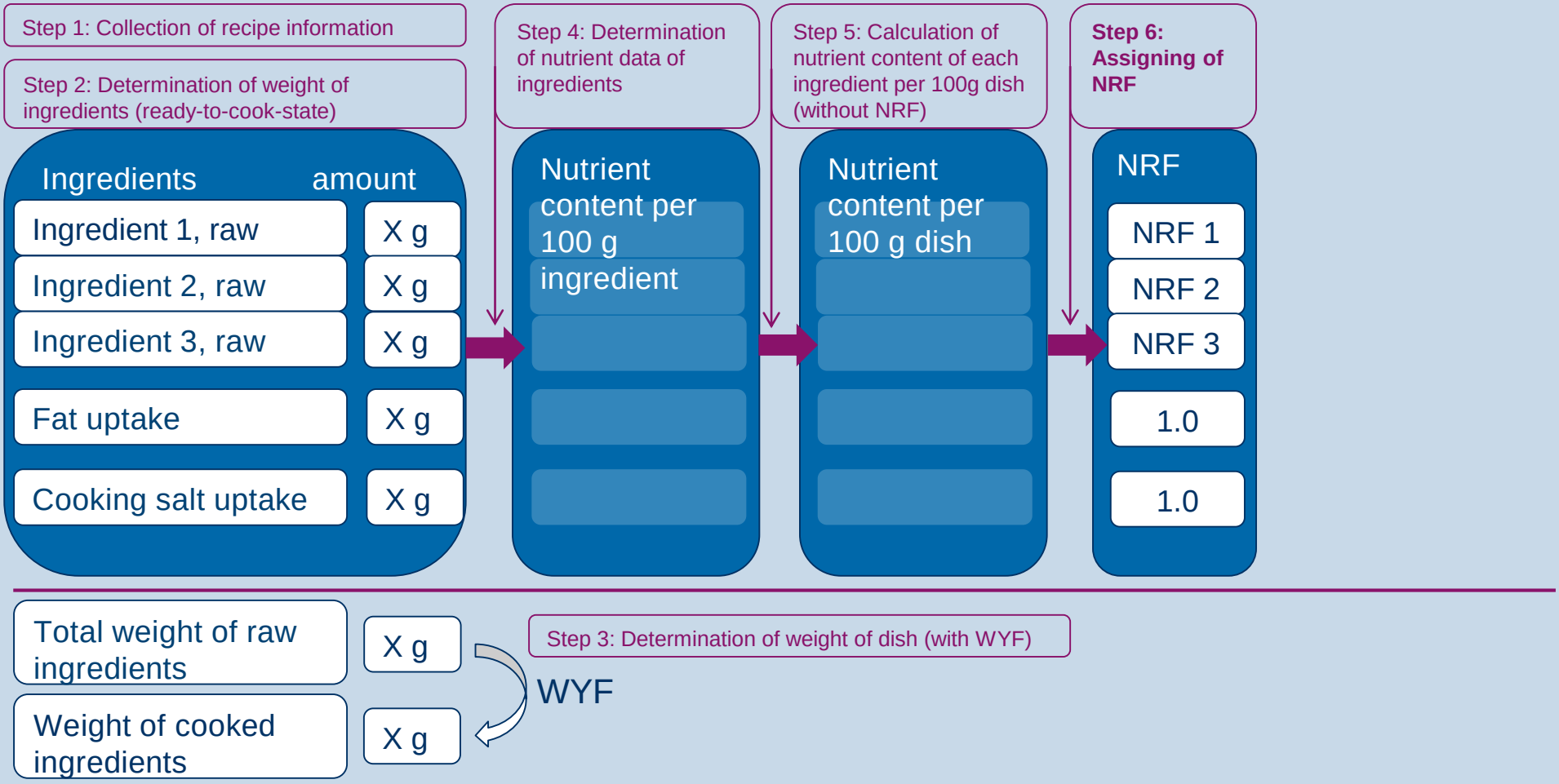


standardized dataset of NRFs to harmonise selection of NRFs within EuroFIR

Vasquez-Caicedo et al. 2008

The only dataset, which offers factors for macronutrients is the publication from Bognar (2002).
At present, the standardised dataset of NRFs for micronutrients is being completed for macronutrients from Bognar at the Max Rubner-Institute.

Step 6: Assigning of NRF (2)



Step 7: Calculation of nutrient content of each ingredient per 100g dish (with NRF) (1)

Formula, to calculate the content of each macro- and micronutrient per 100g of cooked weight for each ingredient with correction for the effect of cooking by considering the NRFs (Bognar, 2002).

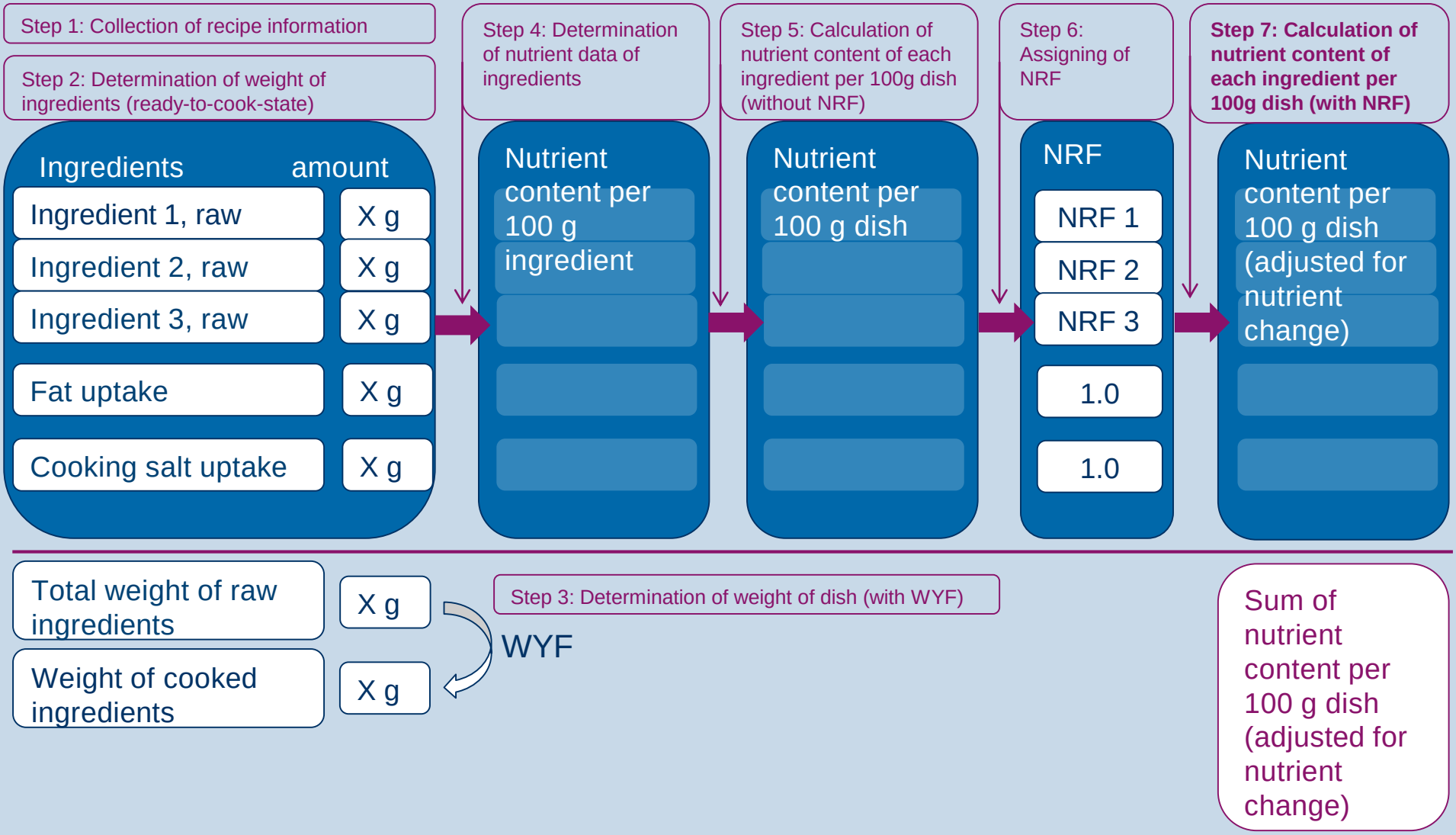
$$\text{Nutrient content of ingredient X per 100 g dish (with NRF)} = \frac{\text{nutrient content per 100 g ingredient} \times \text{raw weight of ingredient (g)} \times \text{NRF}}{\text{weight of prepared dish (g)}}$$

Step 4 - 7: Calculation of thiamine content of apple pie

Ingredient	Weight of ingredient, edible part (g)	Thiamine content			
		Step 4	Step 5	Step 6	Step 7
		µg thiamine per 100g ingredient (BLS)	µg thiamine per 100g dish	NRF	µg thiamine per 100 g dish adjusted for nutrient change
Wheat flour	250	104.0	17.8	0.75	13.4
Chicken egg	165	0.0	0.0	0.85	0.0
Sugar white	150	100.0	10.3	0.80	8.2
Butter	150	5.0	0.5	1.00	0.5
Apple, peeled	750	30.0	15.4	0.80	12.3
Cow's milk, 3.5% fat	62	37.0	1.6	0.75	1.2
Baking powder	6	1.0	0.0	0.75	0.0
Lemon peel	4	0.2	0.0	0.80	0.0
Total weight of raw ingredients	1537				
Weight of baked apple pie*	**1460.2**				**35.6**

$$Thiamin\ content\ of\ wheat\ flour\ per\ 100\ g\ apple\ pie\ (with\ NRF) = \frac{104.0\ \mu g\ \times 250\ g\ \times 0.75}{1460.2\ g} = 13.4\ \mu g$$

Step 7: Calculation of nutrient content of each ing. per 100 g dish (with NRF)



Step 8: Calculation of water content (1)

No NRFs for water as component available

→ 2 alternative calculation methods

Scenario 1:

Weight change is result of only water uptake

→ Calculation by Water as ingredient

Quantity of water difference of prepared dish (g)
= weight of prepared dish (g)
− total weight of all ingredients (g)

Mineral composition of water is taken into account

Scenario 2:

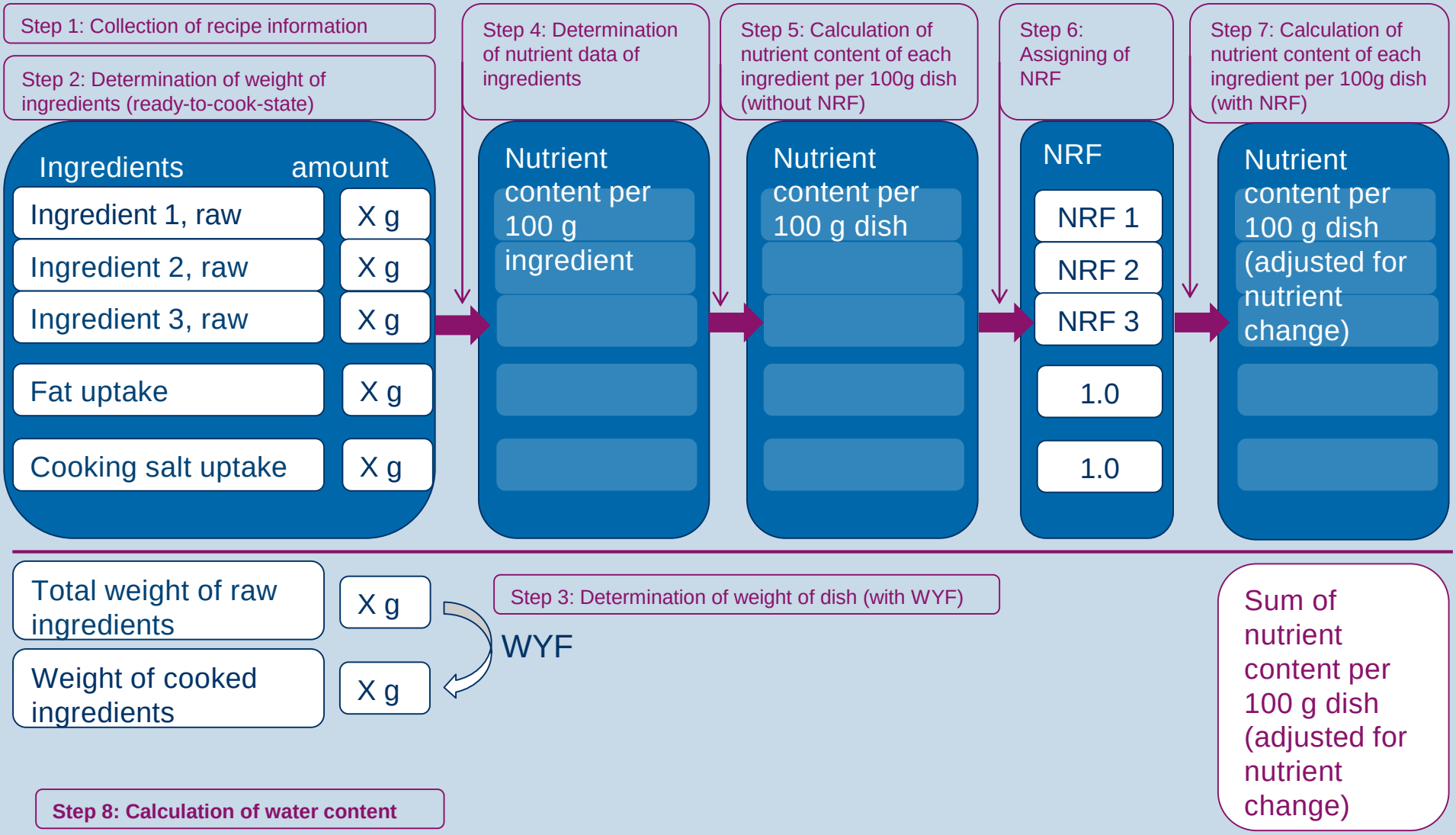
Weight change is result of a combination of water loss/gain, fat loss/gain, alcohol reduction, salt uptake

→ Calculation by difference

Quantity of water per 100g of prepared dish (edible part)
= 100 − protein − fat − carbohydrates (available)
− organic acids − alcohol − dietary fibre − ash

Mineral composition of water is not taken into account

Step 8: Calculation of water content (2)



Questions?
Feedback?
Discussions?

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Calculation of water as component

Calculation of water …

… as ingredient	… according to Marie‘s formula	… by difference	… according to Esther‘s formula
assumption: total weight change = water change		weight change of all components is considered	
suitable only for water gain	suitable for water gain/ water loss	suitable for water gain/ water loss	suitable for water gain/ water loss
Mathematically, both formulas are exactly the same. The difference is, that „Calculation of water as ingredient“ is only suitable for water gain, whereas „Calculation of water according to Marie‘s formula“ is suitable for water gain/ loss.		Mathematically, both formulas are also exactly the same, if the sum of the components of each ingredient is exactly 100 g. If the sum of the components of each ingredient is not equal to 100 g, than the “Calculation of water by difference” compensates this, but the “Calculation of water according to Esther’s formula” maintains the deviation.	

In each case: Make sure, that the fat uptake is considered via fat uptake factors!