

# A web application to reformulate recipe



## through optimization:

## proof of concept



Romane Poinso, Matthieu Maillot,  
Rozenn Gazan & Florent Vieux



# Statistics



Modeling



Marseille



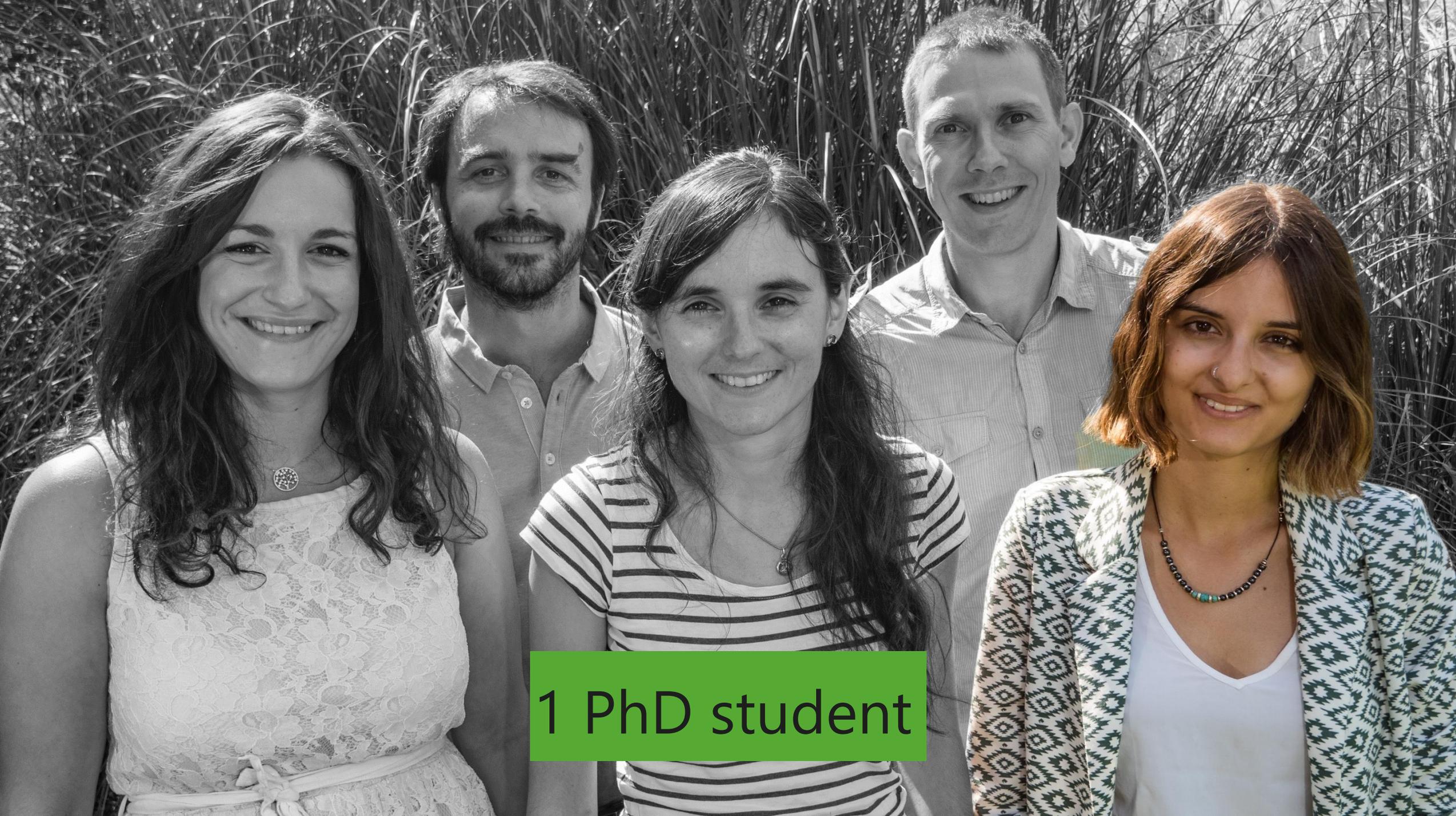
2 cofounder and PhD in Nutrition



1 PhD in Nutrition



1 food engineer



1 PhD student



*Scientific  
knowledges*

*Practical  
tools*

Nutritional food labelling is **mandatory** with

INCO regulation



Energy

Proteins

Fats

Carbohydrates

SFA

Sugars

Salt



Processes altered  
food components and  
modify nutritional  
composition

Nutrients analysis  
in laboratory can be  
**expensive**





# Reformulating recipe is crucial

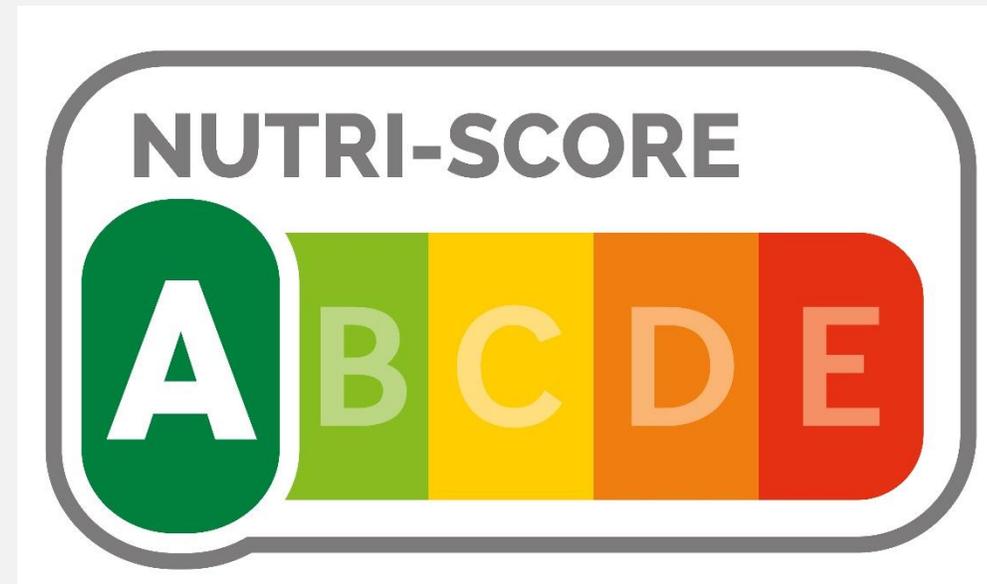
- Improve nutritional quality





# Reformulating recipe is crucial

- Improve nutritional quality
- Gain a better Nutri-Score





# Reformulating recipe is crucial

- Improve nutritional quality
- Gain a better Nutri-Score
- Optimize cost





# Reformulating recipe is crucial

- Improve nutritional quality
- Gain a better Nutri-Score
- Optimize cost
- ...

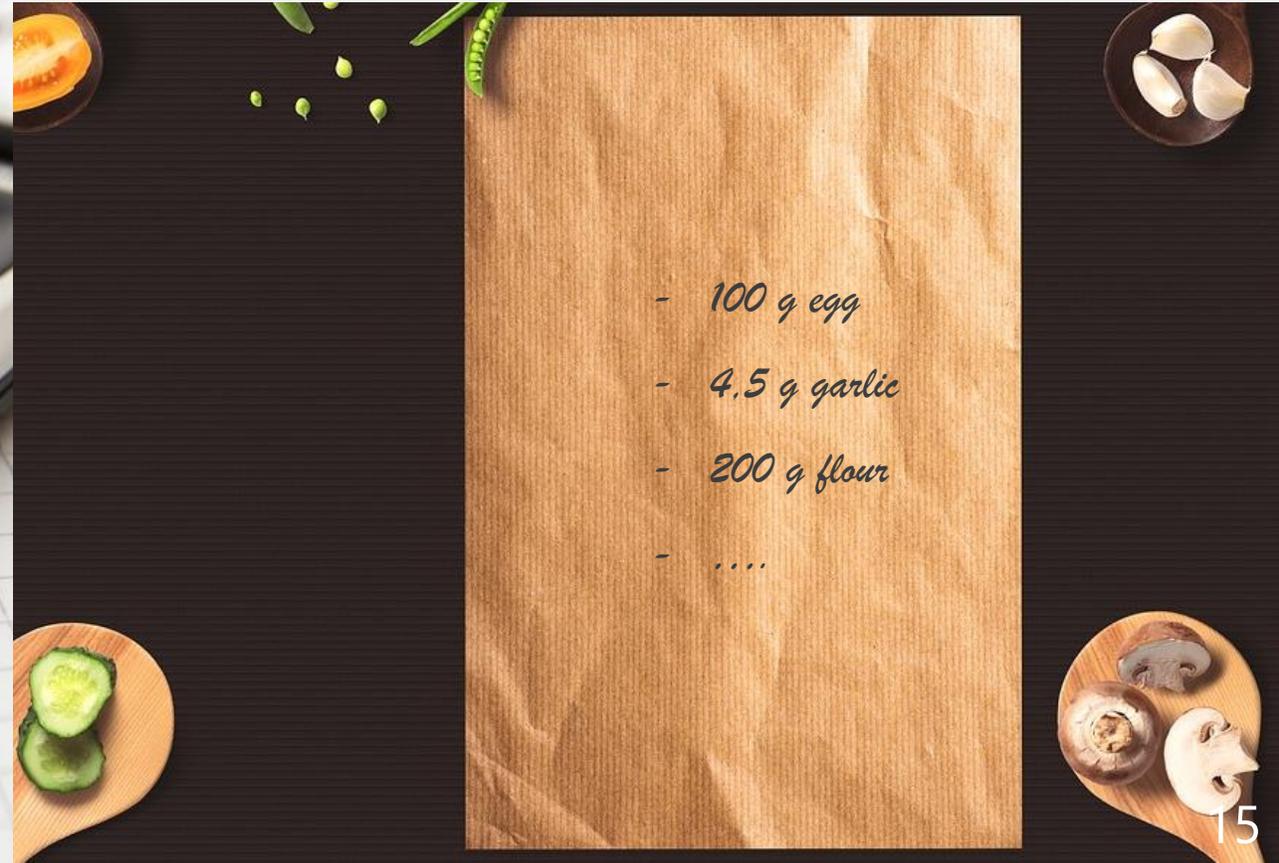
While staying as close as possible to actual recipe !

# Two key issues when developing food products:

Calculate nutritional composition



Recipe formulation



We've created a web-based tool to calculate and improve nutritional composition of processed food:





**How to calculate nutritional composition while taking into account the impact of processes ?**

Machackova, M., Giertlova, A., Porubska, J., Roe, M., Ramos, C. and Finglas, P. (2018), EuroFIR Guideline on calculation of nutrient content of foods for food business operators. *Food Chemistry*, 238, 35-41

## Processes have an impact on nutrients contents

### Losses of nutrients:

Retention depending on pressure, temperature, pH.

### Weight change:

- During cooking: water or fat loss or gain
- After cooking: waste, cooling, ...

Machackova, M., Giertlova, A., Porubska, J., Roe, M., Ramos, C. and Finglas, P. (2018), EuroFIR Guideline on calculation of nutrient content of foods for food business operators. *Food Chemistry*, 238, 35-41

## There are factors to quantify changes in nutrient contents

### Losses of nutrients:

Retention factors:

$$\frac{\text{Nutrient content in the cooked food (g/100g)}}{\text{Nutrient content in the raw food (g/100g)}}$$

### Weight change:

Yield factor:

$$\frac{\text{Total cooked weight (g)}}{\text{Total raw weight of the inputs ingredients (g)}}$$



Recommended recipe calculation method:

« **Mixed method** »<sup>1</sup>:

- Apply **RF** at ingredients level
- Apply **YF** at recipe level

<sup>1</sup> Vásquez-Caicedo, A.L, Bell, S., Hartmann, B. (2008) Report on collection of rules on use of recipe calculation procedures including the use of yield and retention factors for imputing nutrient values for composite foods (D2.2.9), March 2008.

# RF available in tables for dishes or ingredients compiled in the EuroFIR Project

EuroFIR Food Classification	LanguaL Code	Other relevant facets	Cooking method	LanguaL Code	Vit E		Vit K		Vit B1 (Thiamin)	
					Vit E	Source	Vit K	Source	Vit B1	Source
	Facet A			Facet G						
Coffee, tea, cocoa	A0845		steeped	G0036	100	6	100	6	100	6
Coffee	A0845	B1305	steeped	G0036	100	5	100	5	100	1
Tea	A0845	B1623	steeped	G0036	100	5	100	5	100	1
Egg or egg product	A0790		Boiled = Cooked by moist heat	G0014	100	1	100	1	80	1
Fat or oil	A0805		Boiled	G0014	75	2	100	5	100	2
Fruit or fruit product	A0833		Cooked by moist heat	G0012	100	6	100	6	73	6
			Boiled	G0014	100	1	100	1	65	1
			Stewed	G0020	100	1	100	1	80	1
Fruit or fruit product, with liquid	A0833		Boiled	G0014	100	1	100	1	80	1
Processed fruit product	A0834, A0837		Jam, Jelly		100	1	100	1	100	1

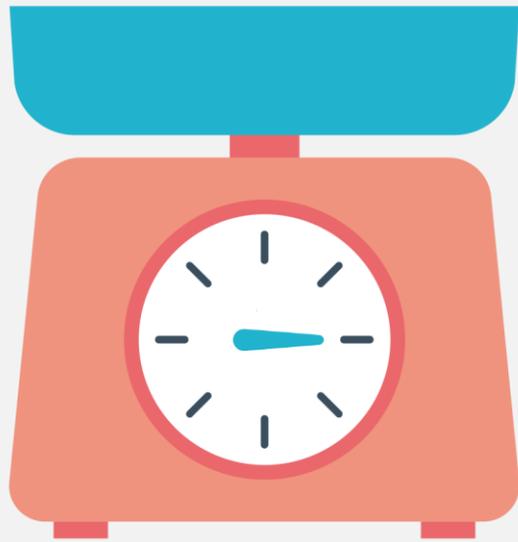
*EuroFIR table for vitamins in fruits*

**YF** available in tables for dishes or ingredients:  
**Bognar or Bergström tables**

Kind of juice	Raw product	Preparation	Yield factor				
			with waste ( $d_{(k,p)}$ )		edible part ( $e_{(k,p)}$ )		n
			$\bar{x}$	$\pm$	$\bar{x}$	$\pm$	
Apple juice	FR o.Z	C	-	-	0.70	-	-
Apple juice	FR m.Z	D	-	-	0.36	-	-
Pear juice	FR o.Z	C	-	-	0.54	-	-
Quince juice	FR m.Z	D	-	-	0.40	-	-
Cherry (sweet, sour), juice	FR o.Z	C	-	-	0.80	-	-
Cherry (sweet, sour), juice	FR m.Z	D	-	-	0.55	0.07	2
Plum, juice	FR m.Z	D	-	-	0.56	-	-

*Bognar table for fruit juices*

**YF** easily calculable by weighing food before and after cooking



Before = 100 g



After = 82 g

**YF = 0.82**

## Retention factors

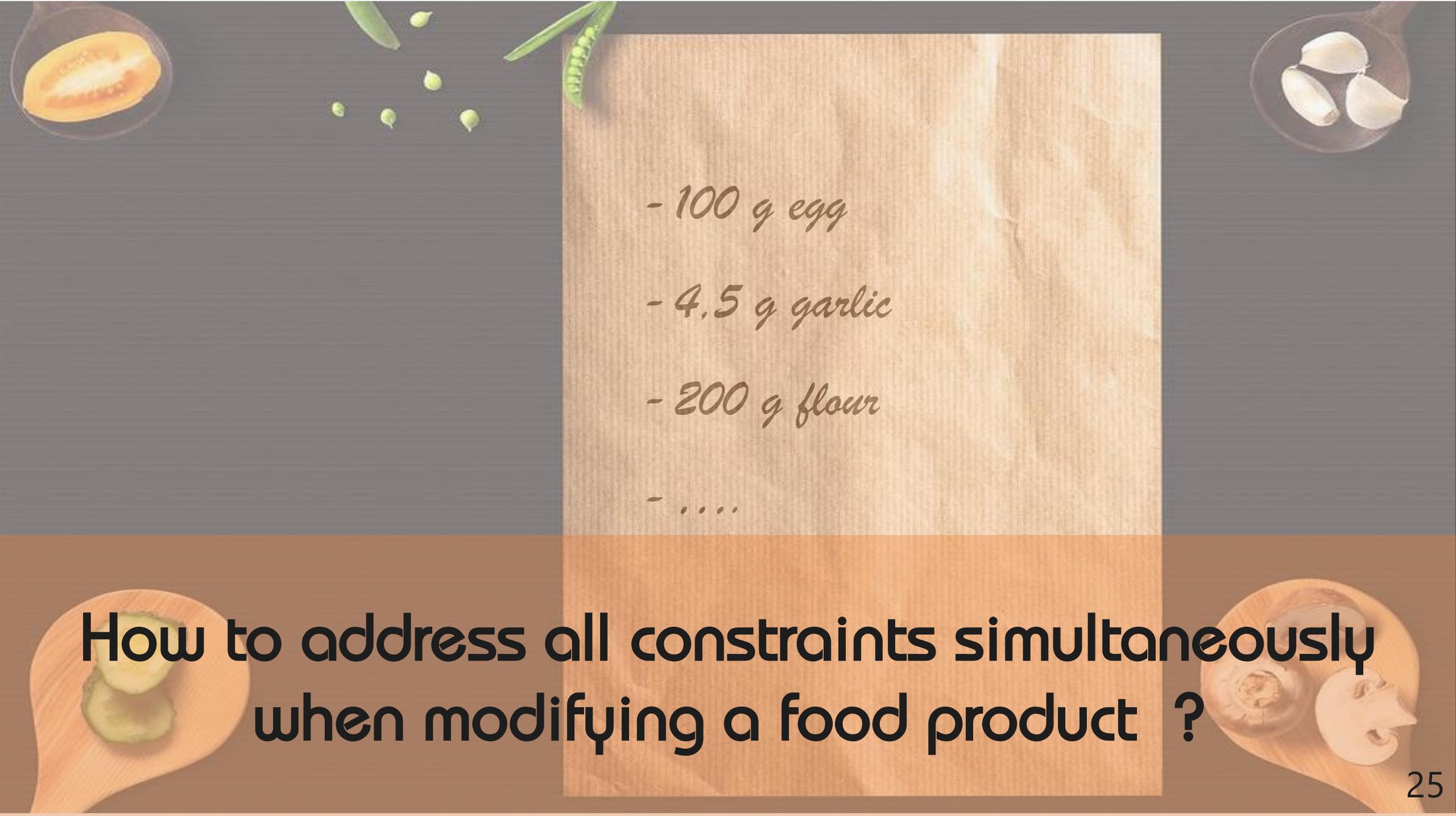
many ingredients and  
process available  
in tables



## Yield factor

difficult to find  
similar dish in tables  
& need to cook the recipe to  
know the YF





- 100 g egg

- 4,5 g garlic

- 200 g flour

- ....

**How to address all constraints simultaneously  
when modifying a food product ?**

# Linear programming: a solving method to improve recipes

Darmon, N., Moy, F. (2008). Un outil à découvrir en nutrition humaine : la programmation linéaire. *Cahiers de Nutrition et Diététique*, 43(6), 303–312.

## 1. INGREDIENTS

- ❖ Ingredients list       
- ❖ Data (nutritional composition, price, process ...)

# Linear programming: a solving method to improve recipes

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## 1. INGREDIENTS

- ❖ Ingredients list       
- ❖ Data (nutritional composition, price, process ...)

## 2. TARGETS

- ❖ On nutrients
- ❖ On ingredients
- ❖ Other: net weight, price, energy, ...

# Linear programming: a solving method to improve recipes

Darmon, N., Moy, F. (2008). Un outil à découvrir en nutrition humaine : la programmation linéaire. *Cahiers de Nutrition et Diététique*, 43(6), 303–312.

## 1. INGREDIENTS = VARIABLES

- ❖ Ingredients list       
- ❖ Data (nutritional composition, price, process ...)

## 2. REQUIREMENTS = CONSTRAINTS

- ❖ On nutrients
- ❖ On ingredients
- ❖ Other: net weight, price, energy, ...

## 3. PROBLEM AT HAND = OBJECTIVE FUNCTION

Minimum deviation with actual recipe ? Minimum cost ? Maximal protein content ?

...

# Linear programming: a solving method to improve recipes

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## 1. INGREDIENTS

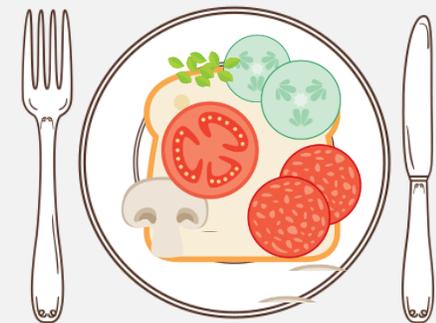


## 2. TARGETS

## 3. PROBLEM AT HAND = OBJECTIVE FUNCTION

## 4. OPTIMISATION

Selection of ingredients to use and their relative amount



## Saisie des ingrédients

Catégorie

Autres

Liquides bouillies

Boissons

Matières grasses

Fromage

Autres

Ajout d'un ingrédient

Ingrédient 1

Pomme de terre crue épuchée

Ingrédient 1 (quantité en g)

382.5

Ingrédient 1 (cuisson) ÉTAPE 1

Poêle (Rôstis)

Supprimer l'ingrédient

Ingrédient 2

Farine de blé tendre

Ingrédient 2 (quantité en g)

100

Ingrédient 2 (cuisson) ÉTAPE 1

Poêle (Pancake)

Supprimer l'ingrédient

Ingrédient 3

Lait demi-écrémé

Ingrédient 3 (quantité en g)

50

Ingrédient 3 (cuisson) ÉTAPE 1

Poêle (Pancake)

Supprimer l'ingrédient

Ingrédient 4

Oeuf de poule

Ingrédient 4 (quantité en g)

20

Ingrédient 4 (cuisson) ÉTAPE 1

Poêle (Pancake)

Supprimer l'ingrédient

Ingrédient 5

Ail

Ingrédient 5 (quantité en g)

4.5

Ingrédient 5 (cuisson) ÉTAPE 1

Poêle

Supprimer l'ingrédient

# Proof of concept

# MS • Recipe

## Input

### Recipe

Quantities of ingredients  
& cooking methods

### Ingredients

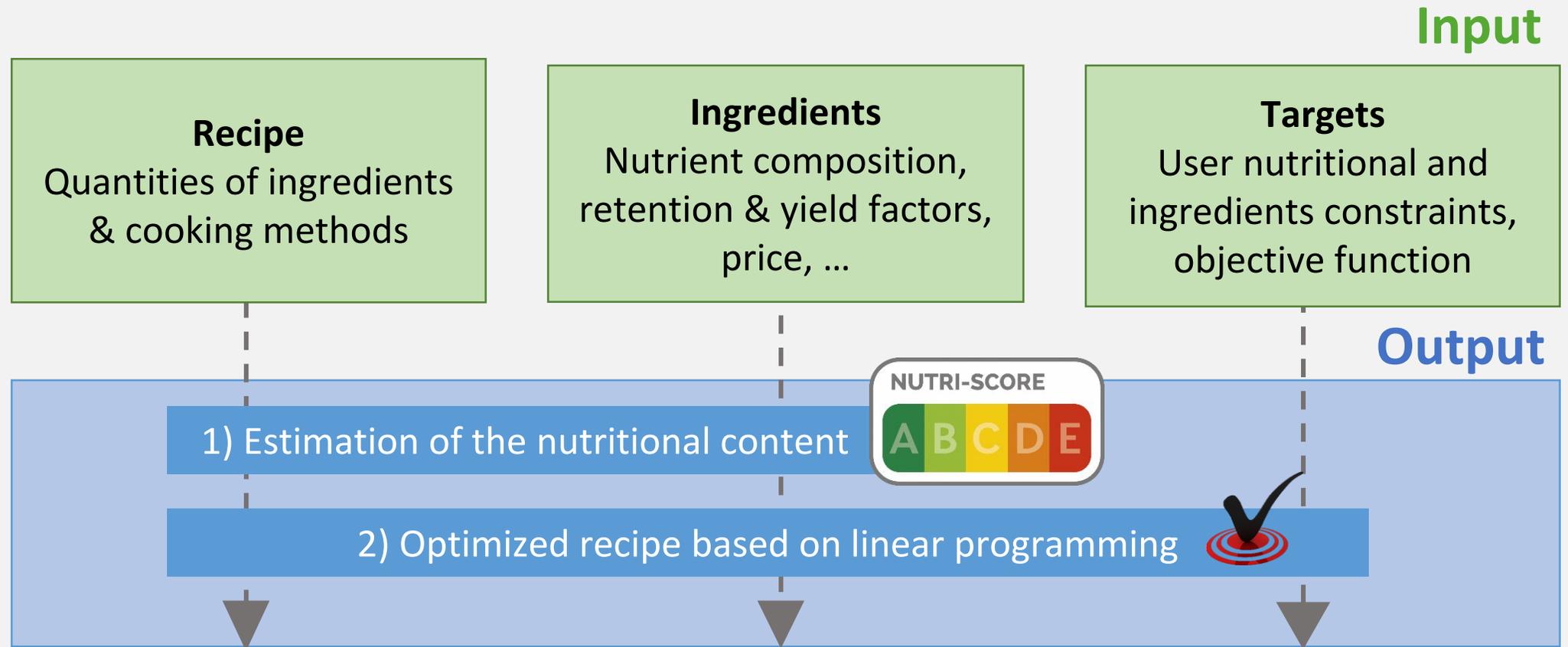
Nutrient composition,  
retention & yield factors,  
price, ...

### Targets

User nutritional and  
ingredients constraints,  
objective function



# MS • Recipe



# Traditional Czech Bramborak dish

*Recipe and ingredients information were taken from EuroFIR guideline*

## Recipe:



Potatoes: 382.5 g  
Wheat flour: 100 g  
Milk: 50 g  
Eggs: 20 g  
Garlic: 4.5 g  
Salt: 5 g  
Lard: 45 g

## Cooking method:



Mix peeled potatoes finely grated + all ingredients

Form small pancakes and fried in hot lard.



Saisie des ingrédients

Catégorie

Autres

Nombre d'étapes

1

Ajout d'un ingrédient

Liste d'ingrédients :

Ingrédient 1

Pomme de terre crue épluchée

Ingrédient 1 (quantite en g)

382.5

Ingrédient 1 (cuisson) ETAPE 1

Poêle (Röstis)

Supprimer l'ingrédient

Ingrédient 2

Farine de blé fine

Ingrédient 2 (quantite en g)

100

Ingrédient 2 (cuisson) ETAPE 1

Poêle (Pancake)

Supprimer l'ingrédient

Ingrédient 3

Lait demi-écrémé

Ingrédient 3 (quantite en g)

50

Ingrédient 3 (cuisson) ETAPE 1

Poêle (Pancake)

Supprimer l'ingrédient

Ingrédient 4

Oeuf de poule

Ingrédient 4 (quantite en g)

20

Ingrédient 4 (cuisson) ETAPE 1

Poêle (Pancake)

Supprimer l'ingrédient

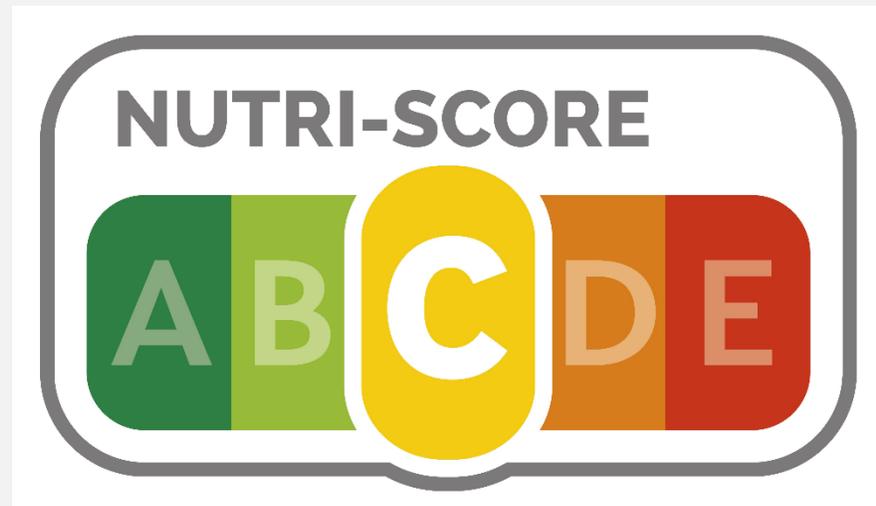
Ingrédient 5

Ingrédient 5 (quantite en g)

Ingrédient 5 (cuisson) ETAPE 1

# Output: Nutritional content in actual recipe

Recette	Nutri-Score	Fruits et légumes (%)	Energie (kcal)	Protéine (g)	Glucides (g)	Sucres (g)	Fibres (g)	Lipides (g)	Acides Gras Saturés (g)	Sel (g)	Sodium (mg)	Calcium (mg)	Vitamine B1 (mg)
Bramborak	C	1.02	254	5.771	31.259	3.629	2.109	11.349	4.735	1.159	463.471	31.253	0.127



# Output: Nutritional content in actual recipe

Recette	Nutri-Score	Fruits et légumes (%)	Energie (kcal)	Protéine (g)	Glucides (g)	Sucres (g)	Fibres (g)	Lipides (g)	Acides Gras Saturés (g)	Sel (g)	Sodium (mg)	Calcium (mg)	Vitamine B1 (mg)
Bramborak	C	1.02	254	5.771	31.259	3.629	2.109	11.349	4.735	1.159	463.471	31.253	0.127

Nutrient	Estimated values in actual recipe
SFA (g/100g)	4.7
Sodium (mg)	463
Fiber (g)	2.1
Proteins (g)	5.8

# Targets set in the model:

Recette	Nutri-Score	Fruits et légumes (%)	Energie (kcal)	Protéine (g)	Glucides (g)	Sucres (g)	Fibres (g)	Lipides (g)	Acides Gras Saturés (g)	Sel (g)	Sodium (mg)	Calcium (mg)	Vitamine B1 (mg)
Bramborak	C	1.02	254	5.771	31.259	3.629	2.109	11.349	4.735	1.159	463.471	31.253	0.127

Nutrient	Estimated values in actual recipe	Nutritional targets
SFA (g/100g)	4,7	$\leq 4$
Sodium (mg)	463	$\leq 360$
Fiber (g)	2.1	$\geq 2.1$
Proteins (% Energy)	9	$\geq 12$

# Targets set in the model:

<b>Ingredient 2</b>	<b>Ingredient 2 (quantite en g)</b>	<b>Ingrédient 2 (cuisson) ETAPE 1</b>	
Farine de blé fine ▼	100 ▼	Poêle (Pancake) ▼	Supprimer l'ingrédient
<b>Ingredient 3</b>	<b>Ingredient 3 (quantite en g)</b>	<b>Ingrédient 3 (cuisson) ETAPE 1</b>	
Lait demi-écrémé ▼	50 ▼	Poêle (Pancake) ▼	Supprimer l'ingrédient
<b>Ingredient 4</b>	<b>Ingredient 4 (quantite en g)</b>	<b>Ingrédient 4 (cuisson) ETAPE 1</b>	
Oeuf de poule ▼	20 ▼	Poêle (Pancake) ▼	Supprimer l'ingrédient

Ingredient	Actual recipe	Ingredients targets
Flour	2 * Milk	2 * Milk
Milk	2.5 * Eggs	2.5 * Eggs

**Objective function:** stay as close as possible to actual recipe



Calcul de la composition nutritionnelle

Amélioration

### Saisie des ingrédients

Catégorie

Autres ▼

Nombre d'étapes

1 ▼

Ajout d'un ingrédient

Liste d'ingrédients :

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Ingrédient 1 (quantite en g)

382.5 ▼

Ingrédient 1 (cuisson) ETAPE 1

Poêle (Röstis) ▼

Supprimer l'ingrédient

Ingrédient 2

Farine de blé fine ▼

Ingrédient 2 (quantite en g)

100 ▼

Ingrédient 2 (cuisson) ETAPE 1

Poêle (Pancake) ▼

Supprimer l'ingrédient

Ingrédient 3

Lait demi-écrémé ▼

Ingrédient 3 (quantite en g)

50 ▼

Ingrédient 3 (cuisson) ETAPE 1

Poêle (Pancake) ▼

Supprimer l'ingrédient

Ingrédient 4

Oeuf de poule ▼

Ingrédient 4 (quantite en g)

20 ▼

Ingrédient 4 (cuisson) ETAPE 1

Poêle (Pancake) ▼

Supprimer l'ingrédient

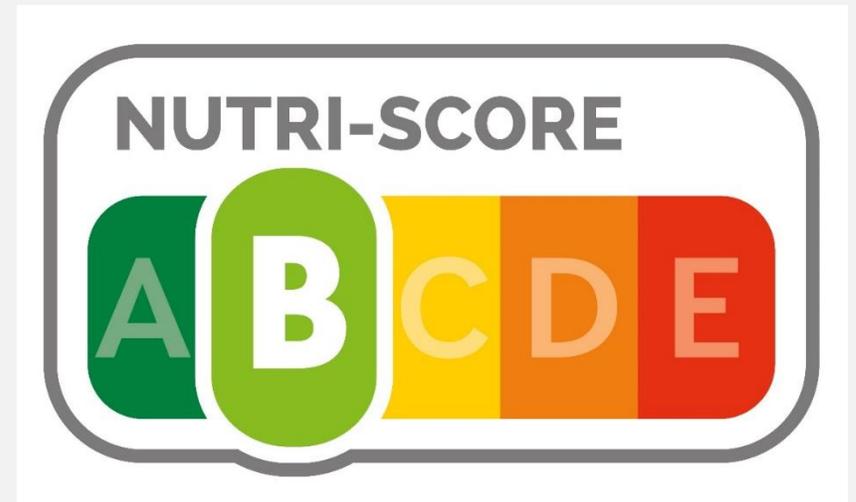
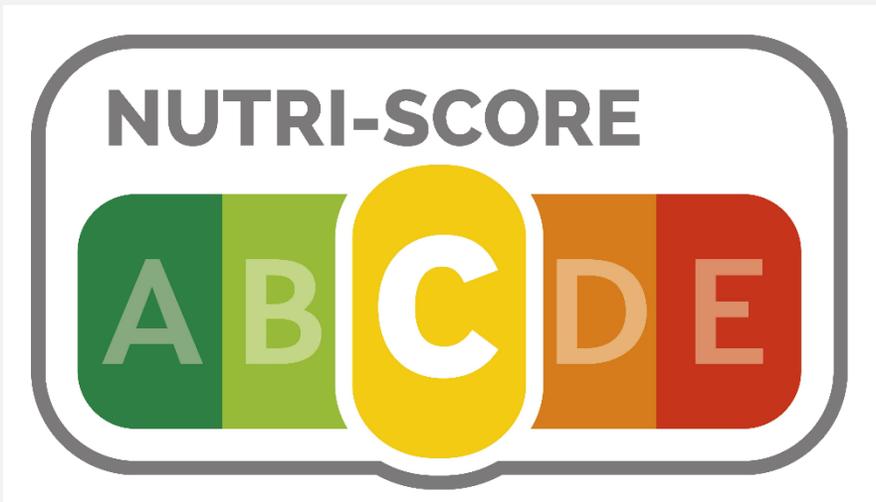
Ingrédient 5

Ingrédient 5 (quantite en g)

Ingrédient 5 (cuisson) ETAPE 1

# Output: Nutritional composition in optimized recipe

Recette	Nutri-Score	Fruits et légumes (%)	Energie (kcal)	Protéine (g)	Glucides (g)	Sucres (g)	Fibres (g)	Lipides (g)	Acides Gras Saturés (g)	Sel (g)	Sodium (mg)	Calcium (mg)
Bramborak améliorée (1)	B	1.52	238	7.131	36.091	3.558	2.159	6.724	2.663	0.894	357.64	39.785
Bramborak	C	1.02	254	5.771	31.259	3.629	2.109	11.349	4.735	1.159	463.471	31.253



# Output: Nutritional composition in optimized recipe

Recette	Nutri-Score	Fruits et légumes (%)	Energie (kcal)	Protéine (g)	Glucides (g)	Sucres (g)	Fibres (g)	Lipides (g)	Acides Gras Saturés (g)	Sel (g)	Sodium (mg)	Calcium (mg)
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Bramborak	C	1.02	254	5.771	31.259	3.629	2.109	11.349	4.735	1.159	463.471	31.253

Nutrient	Targets	Estimated values in optimized recipe
SFA (g/100g)	$\leq 4$	2.66
Sodium (mg)	$\leq 360$	358
Fiber (g)	$\geq 2.1$	2.2
Proteins (% Energy)	$\geq 12$	12

# Output: Optimized recipe

Recette	Ail	Farine de blé fine	Lait demi-écrémé	Oeuf de poule	Pomme de terre crue épluchée	Saindoux	Sel fin ou gros	Poids total avant cuisson	Poids total après cuisson	Prix total	Nutri-Score
Bramborak améliorée	1.52	33.87	16.94	6.77	66.62	5.07	0.85	131.64	100	0.1	B
Bramborak	1	22.6	11.3	4.5	86.3	10.2	1.1	136.99	100	0.11	C

Ingredient	Actual recipe	Optimized recipe
<b>Potatoes</b>	382.5 g	 307.2 g
<b>Wheat flour</b>	100 g	 156.2 g
<b>Milk</b>	50 g	 78.1 g
<b>Eggs</b>	20 g	 31.2 g
<b>Garlic</b>	4.5 g	 7 g
<b>Salt</b>	5 g	 4 g
<b>Lard</b>	45 g	 23.4 g
<b>Total</b>	<b>607 g</b>	 <b>607 g</b>



Proof of concept with one recipe (Bramborak)  
Further development is needed to:

- Expand database with new ingredients and processes
- Allow user to load his own database



Application suitable for food industries, catering, research institutes, ....



**We're looking for partners**



[contact@ms-nutrition.com](mailto:contact@ms-nutrition.com)  
[romane.poinsot@ms-nutrition.com](mailto:romane.poinsot@ms-nutrition.com)



[ms-nutrition.com](http://ms-nutrition.com)



MS-Nutrition (SAS)

MS-RECIPE, a web application capable of:

Estimating nutritional composition and Nutri-Score of a food product

Taking impact of processes into account by the use of yield and retention factors

Suggesting reformulation with personalized optimization based on linear programming