PROORG

# Case study : **Biscuit**

The Case Study aims at testing the practicability of the Code Of Practice for organic food processing, developed in the european project ProOrg.
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# CASE STUDY: BISCUIT

## Practical case study based on industrial data

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# Preface

The work carried out for this report is the result of a collaboration between ITAB (French Institute for Organic Food and Farming), VetAgro Sup engineering school specialized in agronomy and food processing in Clermont Ferrand and a French biscuit manufacturing company.

In the context of the collective engineering project of the VetAgro Sup students, ITAB proposed to apply the Assessment Framework (methodology developed in the European project ProOrg) on the manufacturing processes of two organic biscuits filled with chocolate. The students were in their final year, within the specialization "Food Science for Performance and Innovation". This project lasted a total of 6 months, from October 2020 to March 2021.

The French biscuit company is involved in organic production and has agreed to participate in the ProOrg project but wishes to remain anonymous within the framework of the project. The data, deemed confidential by the industrial operator, will not be written in this technical report. Words used have been validated prior to the publication of this report. The company is warmly thanked for its help on this case.

The students of VetAgro Sup, authors of this report, are Margaux Colombin, Fabien Dulucq, Lisa Giffon and Romain Godard. ITAB supervisors and reviewers of this report are Rodolphe Vidal and Solenne Jourdren.

# 1. Introduction

Biscuit and cake industry is a very heterogenous sector with more than a hundred of companies in France from SME to big international food companies. The chocolate biscuit sector business generated 810 million euros in 2018 for the hypermarkets and supermarkets which represent 72% of the total amount of sales of the sector. Retailer owned brand represented 30% of the biscuit market in France and organic biscuit represented only 3.9% of total sales in volume in 2018 (FAM, 2020). In France, 8 kg of biscuits and cakes are eaten every year (Les Fabricants de Biscuits et Gâteaux de France, Chiffres 2019).

This case study deals with chocolate-filled biscuit processing. This is a practical case study based on industrial data obtained with the help of a French biscuit manufacturing company. The main objective of this study is to test the implementation of the multi-criteria assessment methodology of the European project ProOrg on organic chocolate-filled biscuit manufacturing processes, in an industrial environment. How can the multi-criteria assessment methodology defined by the ProOrg project evaluate processes to produce chocolate-filled biscuits?

Two existing industrial processes were compared and assessed, which led to constraints in data collection and application of the multi-criteria assessment methodology.

# 2. Material and methods

The methodology used is called the Assessment Framework (AF) and was developed in the European project ProOrg. It gives a framework for a multidimensional approach for several aspects in the scope of organic processing i. e. Environmental sustainability, Nutritional quality, and Sensory quality.

## Step 1 of AF: Establishing the context, case boundaries and validate indicators

The studied systems were defined by comparing two process diagrams for chocolate-filled biscuit manufacturing. Both final biscuits were similar but came from different formulations and different unitary operations.

In order to test the Assessment Framework on several parts of the process diagram and in function of the available data in the factory, 3 boundaries were selected (highlighted in orange in the Figure 1).

- 1. Preparation of the biscuit dough before baking
- 2. Formulation of the chocolate filling
- 3. All end-of-line operations

Indicators were selected in agreement with the French company. Indicators that were already measured by the company were preferentially chosen (Table 1).

Environmental sustainability was assessed through energy consumption measurements and profitability indicators. Captors were only present at the end of the lines; therefore, environmental sustainability aspect was only assessed for the case n°3.

Nutritional criteria and indicators were selected according to the mandatory nutrition declaration (regulation (EU) No 1169/2011).

After consultation with the actors of this project, it did not seem relevant to keep the sensory criteria for this case study. In fact, the sensory data were available for only one of the two studied biscuits, because sensory conformity was included in its specification. Adding the analyses on the second biscuit was not possible due to the high testing costs. We therefore preferred not to include the criteria and indicators of the sensory aspect and only keep comparable data within nutritional and sustainability aspects.

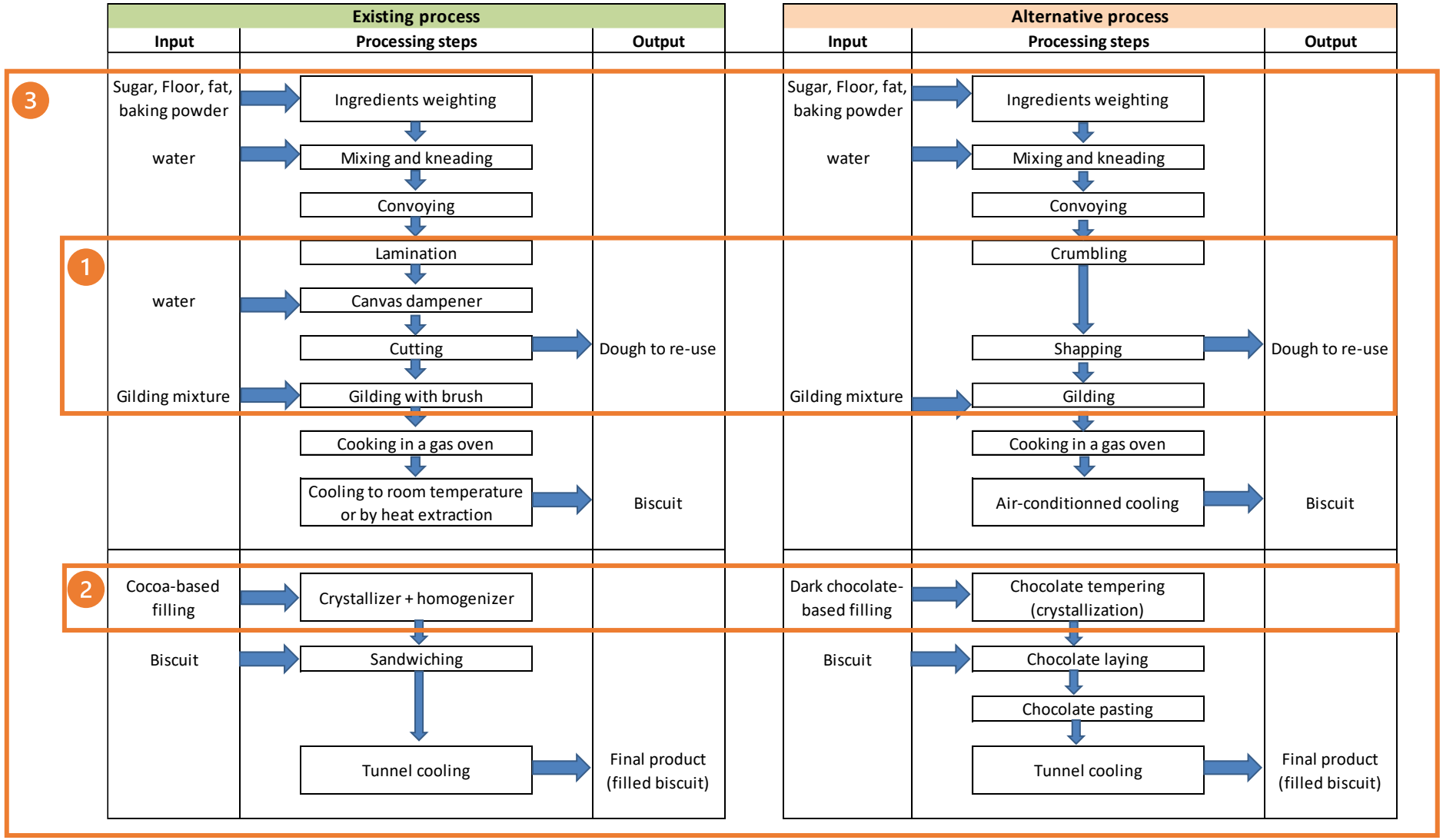


Figure 1. Representation of the process diagrams and of the boundaries of the 3 cases

Table 1. List of criteria, indicators and parameters considered in the study.

| Aspect | Criterion | Indicator | Parameter | Impact |
|---|---|---|---|---|
| Environmental sustainability | Energy consumption | Gas consumption | kWh/kg | + |
| | Energy consumption | Electricity consumption | kWh/kg | - |
| | Energy consumption | Crystallization time | h | - |
| | Energy consumption | Tunnel cooling time | h | - |
| | Profitability | Produced volume | t/day | + |
| | Profitability | Overall Equipment Effectiveness | % | + |
| | Profitability | % Biscuit loss at the end of the line | Kg/kg of produced biscuit | - |
| Nutritional quality | Macronutrient content | Carbohydrates | g/100g | - |
| | Macronutrient content | Sugars | g/100g | - |
| | Macronutrient content | Lipids | g/100g | - |
| | Macronutrient content | Saturated fatty acids | g/100g | - |
| | Macronutrient content | Proteins | g/100g | + |
| | Macronutrient content | Dietary fibers | g/100g | + |
| | Mineral content | Sodium | mg/100g | - |
| | Caloric density | Calories provided by 100g of food | Kcal/100g | - |
| Sensory quality | Not studied in this case study | | | |

The "Impact" column represents the direction of the rating scale (whether the scale is positive or negative, see Table 2). The positive scale is used for an indicator when a lower score indicates a worse performance. On the opposite, the negative scale is used when a lower score indicates a better performance.

Table 2: Conversion of normalized score into rating scale.

| Rating scale | | Normalized score of the alternative technology | |
|---|---|---|---|
| | | Impact + | Impact - |
| -2 | much worse | <50 | >150 |
| -1 | worse | 50-99 | 101-150 |
| 0 | the same | 100 | 100 |
| 1 | better | 101-150 | 50-99 |
| 2 | much better | >150 | <50 |

# 3. Results

## Step 2 of AF: Assessment

The assessment of the 3 selected systems was performed using an Excel tool, named "Assessment Table". We have chosen to use 3 different sheets for the 3 different systems. They will enable us to make a coherent and more detailed comparison of the biscuit transformation processes studied (Table 3). For all the tools, we have X = existing process = process 2 and Y = alternative process = process 1.

When we do not have data from the company on the environmental aspect, it is either due to a lack of measurement during the operations or due to an indicator that is not relevant at this stage.

These three tools score the two processes to compare them. We will therefore be able to compare for each study system, and therefore part of the process operations. In addition, we will be able to see the advantages and disadvantages of each process according to the aspects and criteria. Tool nb.3 contains general data for the assessment of the processes at the end of the line. Also, thanks to the other Excel files which are more focused on "unit operations" of the production, we will be able to support the data of tool nb.3.

Two kinds of assessment were performed:

- Comparison of the two processes by an overall score,
- Naturalness check which gives the impact of each process on the nutritional quality compared to the raw material.

Table 3. Description of the 3 assessed systems

| System number | Purpose: what does the tool allow us to evaluate? | Product studied for both processes | Process 1 = alternative process | Process 2 = existing process | Considered raw material for naturalness check | Weighting of aspects |
|---|---|---|---|---|---|---|
| Nb. 1 | assessment of biscuit dough preparation operations | Biscuit dough | Crumbling + shaping | Lamination + cutting | Dough mix (sugar, flour, water, baking powder) | 100% nutritional aspect |
| Nb. 2 | assessment of the chocolate filling | Chocolate filling | Dark chocolate | Cocoa | - | 100% nutritional aspect |
| Nb. 3 | assessment of all end-of-line operations | Chocolate finished biscuit | Premium Brand specifications | Retailer Brand specifications | - | 50% environmental aspect<br>50% nutritional aspect |

## Step 3 of AF: Overall score and Naturalness check

At the end of the calculations of the Excel tools, the global scores of the studied systems and their naturalness scores were generated (Table 4). In the framework of the assessment of a process in relation to the organic principles, a reference frame (existing process) was defined. Its overall score is equal to 0 and defines the baseline for evaluation.

Table 4. Results of the scores obtained from the 3 Excels "Assessment Table" tools in the framework of the project

| System number | System boundaries | Overall score of the alternative process | Naturalness - Existing process | Naturalness - Alternative process |
|---|---|---|---|---|
| Nb. 1 | assessment of biscuit dough | -0,222 | -0,889 | -0,056 |
| Nb. 2 | assessment of the chocolate filling | 0,944 | | |
| Nb. 3 | assessment of all end-of-line operations | -0,292 | | |

The following interpretations have been made using the Assessment Framework from ProOrg. Thus, some elements were not considered because they did not fall within the criteria of this method. Therefore, the interpretations are only valid in the context of the ProOrg methodology.

## Assessment of biscuit dough preparation operations

For the assessment of biscuit dough preparation operations, the overall score of the alternative process is -0,222. This score is lower than 0, so the quality of the organic dough obtained from the existing process is more in line with the principles of organic production than that of the biscuit obtained from the alternative process. This can be explained by the fact that the dough obtained from the alternative process is lower in saturated fatty acids but with a higher calory density which weight for a third of the overall score (Figure 1).

For naturalness check, the chosen reference is the raw product, *i. e.* in this case the mixtures of ingredients for each biscuit dough according to the recipes provided by the manufacturer. Data of raw products were calculated from the nutritional declaration of ingredients, while data of dough products came from nutritional analyses.

The "naturalness" score of the product resulting from the alternative process is -0.056. The naturalness score of the product from the existing process is -0.889. The deviation from the raw product is greater in the case of the existing process, so the alternative process better preserves the “naturalness” of the product. For the lipid indicator, the dough of the biscuit from the alternative process (with crumbling) after processing has a rating scale score of 0, while the dough of the biscuit from the existing process (with lamination) has a rating scale score of -2. This means that the amount of fat increases after processing in dough from the lamination process. In addition, there are proportionally less saturated fatty acids and more dietary fiber after processing in the alternative process dough (with crumbling). While more saturated fatty acids and less fiber are found in the dough from the existing process after processing (with lamination).

This difference can be explained by the processing step, which is different between the two processes. For the existing process, the technology used to prepare the biscuit dough prior to baking is rolling. This process acts on the dough via a plastic deformation obtained by continuous compression as it passes between two counter-rotating rolls (rotating in opposite directions) called a "rolling mill" (wikipedia "lamination"). But the calculation from nutritional declaration of ingredients is also a possible source of the observed gap.

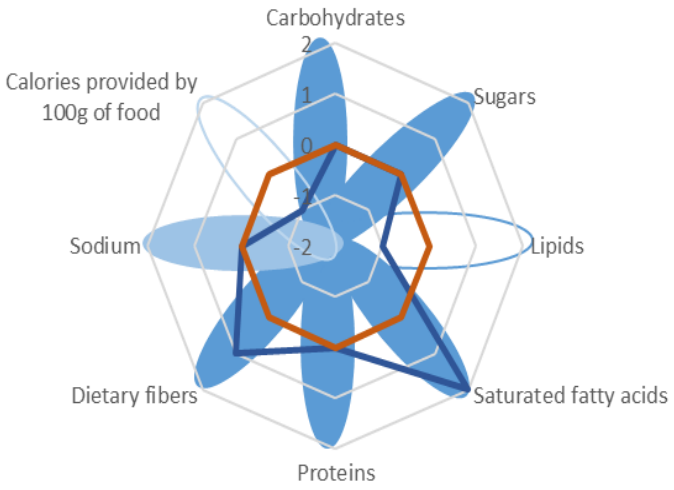


Figure 2. Representation of the indicator rating score of the nutritional aspect focused on the assessment of the raw dough for alternative process in blue line (0 = baseline for reference, in red)

## Assessment of the chocolate filling formulation

For the assessment of the chocolate filling, the overall score of the alternative process is 0.944. This score is higher than 0, which means that the quality of the chocolate filling of the biscuit produced by the alternative process is more in line with organic principles than that of the biscuit produced by the existing process. Indeed, the chocolate filling from the alternative process (dark chocolate based) is lower in sodium, fat and calories than the filling from the existing process (cocoa based) (Figure 3). It also contains more dietary fiber. We could also have considered other criteria such as the % of magnesium in the filling for example.

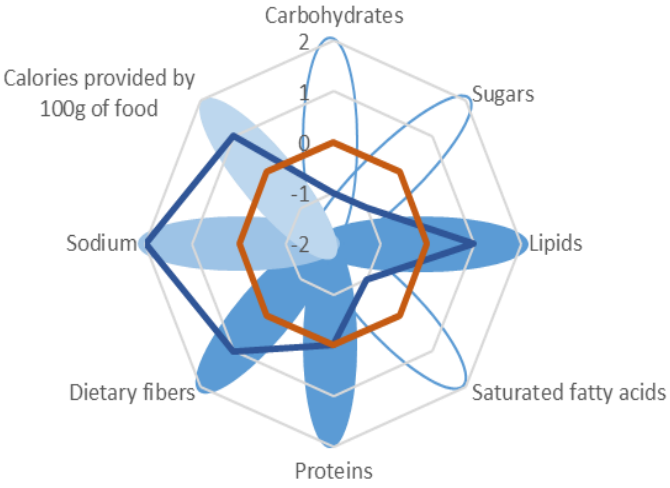


Figure 3. Representation of the indicator rating scale of the nutritional aspect for assessment of the naturalness of the chocolate filling for alternative process in blue line (0 = baseline for reference, in red)

*N.B.: The AF was designed to compare two technologies, not two formulations: therefore, the assessment of the chocolate filing is not really in line with the purpose of the AF.*

## Assessment of all end-of-line operations

For the assessment of all the operations at the end of the line, the overall score of the alternative process is equal to -0.292. This score is lower than 0, so the quality of the organic biscuit obtained from the alternative process is less in line with the principles of organic production than that of the biscuit obtained from the existing process.

This can be explained by the indicator scores of the environmental aspect. The manufacturing operations of the alternative process have a higher overall environmental impact than the existing process, especially on electricity consumption, crystallization time and the percentage of biscuit loss at the end of the line, which obtained a -2 score (Figure 4). The "profitability" criterion, which includes the following indicators: production volume, overall equipment effectiveness and quantity of non-compliance, has a lower score (-1.333) than the "energy consumption" criterion (-0.500).

This difference can be explained by the specifications of the different biscuits. Those from the alternative process are more demanding on the compliance of the biscuits and therefore require a higher baking time, a greater spacing between the biscuits when baking in the oven. Nevertheless, the oven of the alternative process seems to be more energy intensive for a similar use according to the manufacturer.

For the nutritional aspect, the finished product from the alternative process contains more fats and saturated fatty acids than the finished product from the existing process, (Figure 4). Both biscuits contain similar amount of carbohydrates and sugars and similar energy density. The biscuit from the alternative process contains more proteins and dietary fibers but less sodium than the one from the existing process, which lead to a nutritional score of 0.333.

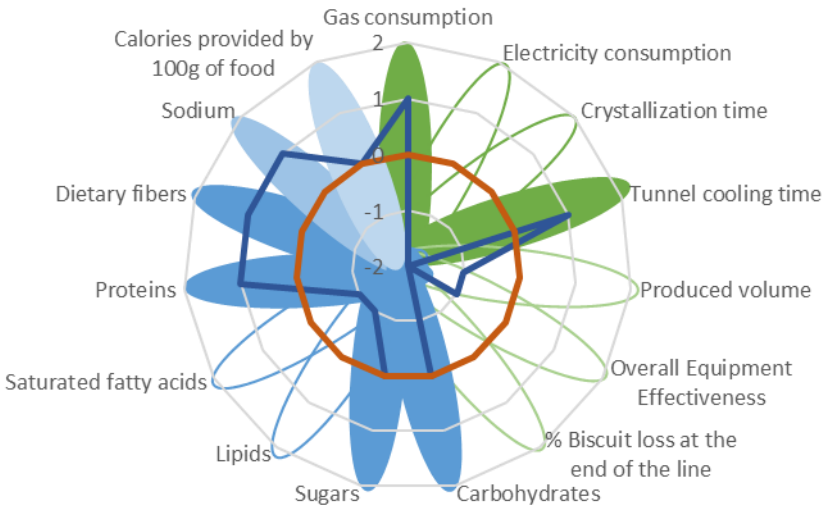


Figure 4 Representation of the indicator rating scale of the environmental (in green) and nutritional (in blue) aspects for the assessment of the end-of-line operations

# 4. Discussion

## Limitations & perspectives of the methodology

The assessment framework of the ProOrg project gives rise to many reflections on the method itself but also on the issues arising from it. We have taken the initiative of producing several comments that describe the limitations of the methodology with suggestion for improvement that could be used as a lever for action with the project partners. The following subsections are ranked according to the severity of the presented issue (1 = low to 4 = high/discredits the project).

### Data collection (4: high)

In the case of complex manufacturing processes, operators do not control essential points to apply the methodology (sustainability aspect not measured, nutritional aspect between process operations not measured...etc.). There is thus a high risk of accurate data lacking. We propose some ideas to better control the data collection phase:

- At an upstream stage, arrange to contact specialist interlocutors in each aspect. Tell them precisely their tasks in the project: data to be collected, deadlines, key meetings. This makes it possible to plan and share the many demands. Allows for different points of view.
- Carry out a risk analysis linked to data collection to plan corrective actions.
- Prior to the project, plan a short training on the methodology for the interlocutors to prepare them for the expected level of accuracy.

### Definition of a + or - impact for the sensory aspect (4: high)

The +/- impacts seem difficult to consider for the sensory aspect. Indeed, during a sensory test there are rating scales in relation to a reference product or in relation to preference grids: it seems difficult to judge with + or - the impact on the product on organic principles.

Moreover, at the present time, all the impacts are defined by the industrial partner depending on its marketing strategy, so this can deviate from the organic principles (its will is not always in line with the definition of the organic principles).

- Understand the stakes of organic principles on this sensory aspect: what are the requirements in terms of sensory quality of the product for it to be recognized as organic? According to these requirements, those concerning the industrialist's will can be combined to know if a criterion is judged + or -.
- Set up a database of trained and willing juries. A communication/recruitment campaign could be envisaged to build a panel of mobile and voluntary experts specialized in this methodology.

## Normalization of score (4: high)

For the determination of the indicator rating scores, the normalization scale (which ranges from -2 to 2) is not precise enough because there is no room for normalizing an alternative process indicator that is almost identical to the existing process indicator. This leads to identical indicator rating scores for a very wide range of measured values for the alternative process indicators.

- Set up a more rigorous scale that discriminates more relevantly between products (continuous scale for example).

## Calculations in the Assessment Table (3: medium to high)

The repeatability of measurements (pH, temperature, etc.) is not the same for all processes assessed.

- Implement a protocol that estimates the minimum number of repetitions to be performed in order to make the measurements reliable.

## Sensory aspect (3: medium to high)

Sensory criteria are difficult to adapt to this methodology. The requirements for organic and conventional in terms of sensory quality are quite similar.

- For the sensory aspect, it is important to research upstream what differs between the principles of conventional and organic products. At the end of this research, it will be necessary to look at these comparison criteria.
- Manufacturers often carry out sensory analyses on their finished products and compare them to a target reference. A bonus/malus system could therefore be introduced to reward the process where the products are closest to the target and therefore do not generate non-conformity.

## Weighting of criteria (3: medium to high)

The balanced weighting factors for all criteria do not seem representative. In reality, the weighting is not equivalent, because it is linked to the number of indicators inside a criterion.

- Based on the requirements of the organic principles, it should be analyzed for each type of process which criterion should be emphasized over the others and thus define the weighting factors. Equivalence is a neutral opinion but does not seem to value or not value efforts on this or that criterion in relation to the organic principles.

### Measuring naturalness for processed products (1: low)

The naturalness index cannot be calculated on complex processed foods: it makes no sense to take into account the raw material data if there are multiple processing step and if we expect to produce a completely different food product compared to the raw material (e.g. comparing nutritionnal quality of grapes to those of wine). This is relevant when the raw material undergoes one main transformation (example: an apple transformed into apple juice undergoes only one main transformation).

- Raw materials and intermediate products could already have a naturalness index. This would provide a set of starting data to calculate the naturalness of a raw product. For example, in our case, the naturalness index of the biscuit dough could be calculated from the indices of each raw material (flour, butter...). However, this data is not accessible or is only very rarely measured. Moreover, the different traceability and origin of the raw materials would make this logistically difficult in the case of these "complex" products.

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