TeRiFiQ

Project no. 289397

Combining **Te**chnologies to achieve significant binary **R**eductions **i**n Sodium, **F**at and Sugar content **i**n everyday foods whilst optimizing their nutritional **Q**uality

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Deliverable D1.3

Report on the influence of salt optimisation on the quality in the European main cheese-types

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Dissemination level	
PU Public (must be available on the website)	[x]
PP Restricted to other programme participants (including the Commission Services)	[ ]
RE Restricted to a group specified by the consortium (including the Commission Services)	[ ]
CO Confidential, only for members of the consortium (including the Commission Services)	[ ]

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(*) Note: It was foreseen that the deliverable was written by Herve Société but, in agreement with the other partners, this deliverable was written in common by partners Actia (Actalia) and Herve Société.

1. Summary

1.1 Objectives of the deliverable

As described previously (Deliverable D1.1), a correct (- 20% and - 30%) reduction of salt level in four cheese types (Brie, a soft model cheese; Trappist, a traditional semi-hard cheese; Raclette, a semi-hard cheese model and Bout d'Fagne, a Belgian smear-type cheese) was obtained by partners ACTIA (Actalia), HERVE and ORVAL. The lactic fermentation and composition of cheese were correctly managed as we showed in the deliverable D1.1. In the deliverable D1.2 it was shown that the main mechanisms of ripening: lipolysis and proteolysis were not deeply modified by salt reduction by 30%.
Does this modification of salt levels influence the final cheese quality?
This deliverable D1.3 aims at answering this question and describing the influence of reduction of the salt content in experimental cheeses on the final quality measured by rigorous sensory analysis, the sensory techniques being well-defined and described.

1.2 Main results obtained and next steps

The sensory analysis of low-salt experimental cheeses showed that the salt reduction was systematically perceived. Other consequences on cheese texture, odour or aromas were globally slight and variable, depending on the type of cheese.

The only exceptions were the *acid and pungent taste* that seemed to be reduced in low-salt cheeses (3 cases/4).

The salt-level reduction did not modify the smell and aromatic richness of Bout d'Fagne and Trappist Cheese.

An important defect related to butyric acid fermentation unexpectedly appears in some low-salt Trappist cheese giving a unacceptable appearance (presence of holes).

An important defect was the presence of white moulds (*Penicillium camemberti*) which appeared in a notable proportion of low-salt Bout d'Fagne cheese. This is a defect of presentation.

The partners 2, 7 and 12 will study the possible correction of these two defects (next deliverable 1.4).

2. Introduction

2.1 Influence of salt on cheese quality

Even though the influence of salt on cheese salty taste is well known (Kerjean and Richoux 2003), it is still difficult to analyse the detailed influence of salt reduction on the different taste and flavour which defines the "typicality" of each cheese type. It is supposed that the increase of some fermentation (propionic acid fermentation in Emmental cheese) or some typical enzymatic activity (proteolytic activity, even if not clearly measured – see Deliverable 1.2) could improve the typical taste and/or aroma of hard and soft cheese but nothing is clearly demonstrated. This study has the objective to produce a set of data on the sensorial quality of hard cheeses (commercial Trappist cheese, experimental Raclette cheese) and soft cheeses (experimental Brie cheese, commercial smear cheese Bout d'Fagne), this quality being measured with detailed and standardised procedures by a specialised laboratory (Actalia, Rennes, France) and on a sufficient number of cheeses.

Salt is well known to regulate water activity (aw) in cheese. This aw is the main tool for controlling desirable (lactic, ripening starters) and undesirable fermentations. Two examples are well known (Guinee and *al* 2007):

1) the control of the butyric acid fermentation in hard cheeses, due to the milk spoilage by *Clostridium tyrobutyricum* from silage;

2) the repression of mould growth in soft smear cheeses.

One important aspect of this study is to check that the 30% salt lowering does not impair the ability to control desirable and undesirable fermentations.

2.2 Types of cheeses

Four types of cheese were studied two semi-hard cheese types: Raclette (model cheese) and Trappiste (commercial cheese), two soft cheese types: Brie (model cheese with moulds) and Bout d'Fagne (commercial cheese with smear).

Type of Cheese	Cheese Plant	Variants : salt reduction rate	Number of trials/variant
Brie Cheese	ACTALIA	Standard : / SaltReduct1 : 17% SaltReduct2 : 24%	3 3 3
Raclette Cheese	ACTALIA	Standard : / SaltReduct1 :14% SaltReduct2 : 29%	3 3 3
Trappiste Cheese	ORVAL	Standard : SaltReduct1 : ▫20% SaltReduct2 : ▫30%	7 7 7
Bou d' Fagne Cheese	HERVE	Standard : / SaltReduct1 : 10% SaltReduct2: 10%	7 7 7

2.3 Targets of the experimental work

a. To measure the influence of salt level on salty taste in four cheese types: Trappist (commercial semi-hard cheese), Raclette (experimental semi-hard cheese); Camembert (experimental soft cheese with mould); Bout d'Fagne (commercial soft cheese with smear)
b. To evaluate the influence of salt level reduction on other sensorial qualities by a quantitative method (sensorial profile);
c. To check the influence of salt level reduction on aroma and odours by a qualitative method

2.4 Analytical sensory methods

The methodology used in this study was based on two complementary approaches: a qualitative approach oriented to the characterization of the odours and aromas detected in the cheeses and a quantitative descriptive sensory profile which enabled to characterize the cheeses also on aspect and texture parameters. For Brie and Raclette cheeses, only the sensory profile was performed.

2.4.1. Characterization of the cheese odours and aromas

This analysis enabled us to characterize each cheese by associating to each product some odours and flavours/aromas. The characterization is performed by a sensory analysis panel composed of 14 to 15 trained assessors.
The approach included a stage of training, and a final evaluation with replicate. During this second step, for each product, assessors first ticked all the odours they detected in the products among the 53 proposed. Those 53 odours and flavours are characteristic odours and flavours of cheeses and dairy products.

LIST OF ODOURS AND AROMAS/FLAVOURS ATTRIBUTES			
Apricot/Peach	Coffee	Grassy	Foot
Acetaldehyde	Cellar	Boiled milk	Plastic
Garlic	Fungus	Fresh milk	Pear
Alcohol	Lemon	Baking yeast	Pepper
Ammonia	Cooked cabbage	Malt	Potato
Pineapple	Clove	Honey	Propionic
Animal	Fresh cream	Nutmeg	Putrid
Butter	Crust of bread	Hazelnut	Rancid
Wood	Cumin	Walnut	Resin
Beef flavour	Cow shed	Cooked onion	Soap
Wet box	Flower	Straw	Sulphur
Butyric	Hay	Whey	Ground
Caramel	Blue cheese	Pharmaceutical	Vinegar
+ Pungent (Aroma/flavours only)			

2.4.2. The sensory profile

This ***descriptive*** approach was based on the sensory profile method. This analysis enabled us to create the sensory ID-card of the cheeses and to identify organoleptic differences between products.
The panel was composed by 15 assessors selected and trained in the evaluation of dairy products. The training of this group of assessors was realized in our laboratory of Rennes (Ille-et-Vilaine, France) according to the recommendations of the Standard ISO 8586-1: Sensory analysis – General guidance for the selection, training and monitoring of assessors – Part 1: selected assessors.

The approach included 3 steps:
- 1st step: the generation of vocabulary aimed to identify all the sensory characteristics of the studied products.
- 2nd step: training of the assessors on final list of characteristics
- 3rd step: final evaluation: For each product, the intensity of the chosen characteristic was scored by the assessors. The scoring was carried out on a gradual intensity scale, delimited by semantic references (for example from *not acid* to *very acid*) whose extremities were 0 and 10 in the data treatment.

2.4.3. Technical conditions

The tasting sessions took place in a laboratory with defined and controlled conditions in accordance with the Standard NF ISO 8589 (2007) « Sensory analysis – General guidance for the design of test rooms ».
Sessions for Bout d'Fagne Cheese

◦ 7 characterization sessions for the evaluation of 21 products = 3 variants * 7 cheese making between 05/16/12 and 07/05/12. A tasting session corresponded to the evaluation of the three cheese variants of one cheese making.

◦ 7 profile sessions for the evaluation of 21 products = 3 variants * 7 cheese making and 3 products evaluated by session, between 05/16/12 and 07/05/12; with 2 preceding sessions for generation of vocabulary and training.
Sessions for Trappist Cheese

◦ 7 characterization sessions for the evaluation of 21 products = 3 variants * 7 cheese making between 04/16/12 and 05/02/12. A tasting session corresponds to the evaluation of the three cheese variants of one cheese making. profile sessions for the evaluation of 21 products = 3 variants * 7 cheese making and 3 or 6 products evaluated by session, between 04/17/12 and 05/03/12, with 2 preceding sessions for generation of vocabulary and training.
Sessions for Raclette cheese :

◦ 3 profile sessions for the evaluation of 9 products: 3 variants * 3 cheese making and 3 products evaluated by session between 06/04/12 and 06/06/12, with a preceding training session.
Sessions for Brie cheese :

◦ Training: 04/12/12

◦ 2 profile sessions for the evaluation of 9 products: 3 variants * 3 cheese making and 3 or 6 products evaluated by session 04/18/12 and 04/20/12 with a preceding training session.
Preparation and presentation of the samples

The cheeses were put at a temperature of 15°C during two hours before the tasting session. Assessors received a portion of 50 grams of cheese (with the rind) to make their evaluation. The samples were presented anonymously and were identified by a three digit number randomly allocated. The code was different between the replications. **The evaluation order of cheeses was variable from an assessor to the other one, to avoid presentation rank effects.**

2.5 Data analysis

The goal of this data analysis was to evaluate the organoleptic characteristics of the different experimental cheeses. More precisely, we intended to analyse the impact of the different salt levels on the sensory properties of the cheeses, and particularly regarding smell and flavours.

For the qualitative approach
For each product, the number of quotations of each aromatic note was counted. Then, the results were analysed with a chi^2 test to determine if some attributes underlined differences between our three products.A multidimensional analysis (PCA) was performed to synthesize all the information by showing the proximity between the samples, considering only the attributes which obtained more than 10% of quotations for one of the three cheeses at least.

For the sensory profile
We calculated the mean and the confidence interval associated to each sample for each attribute. The comparison of the means was based on an analysis of variance which tended to identify the significant differences between the products. The objective of this analysis was firstly to identify the organoleptic differences between the samples. Secondly, it helped to evaluate the impact of the different salt levels on sensory characteristics.
The sensory profiles of the products were also represented.
A multidimensional analysis (PCA) was performed to synthesize all the information by showing the proximity between the samples, all parameters being considered.

3. Results and Discussion

3.1 Incidence on the salty taste

The consumers clearly perceived the salt reduction influence of salty taste for all the studied type of cheese.

For the Raclette cheese and the Trappist cheese, the three variants were differentiated. Those differences were stable, whatever the cheese making, for the Raclette but not for the Trappist Cheese.

For the Bout d'Fagne the differences were significant only between the more salt reduced variant and the others variants, and those differences were not stable whatever the cheese making.

For the Brie the differences were stable and significant between the standard and the more salt reduced variant. The other variant (Salreduct1) had an intermediary position.

	Salty Taste intensity		
Raclette	SaltRed2	< SaltRed1	< Standard
	4,8	5,1	5,6
Brie	SaltRed2	Salt Red1	Standard
	4,3	4,5	4,7
Bou d'Fagne	SaltRed2	< SaltRed1	Standard
	5,9	6,2	6,4
Trappist	SaltRed2	< SaltRed1	< Standard
	4,0	4,4	5,0

Legend: < corresponds to a significant difference with a statistical risk or error value inferior to 5%

**in the absence of significant difference between products, at the level of 5%, those products are underlined.*

3.2 Other taste and texture characteristics

- As shown in Annex 1, the bitter and acid taste seemed to be strengthened with the increase of salt rate (this is verified in 3 cases on 4). The texture is not significantly modified.

- The cheese maker noted that the low salt Trappist cheese is sometimes characterised by a butyric taste and presence of abnormal holes. In some case this defect was demonstrated by butyric acid analysis, the level of butyric acid being higher than 500 ppm (traditional empirical limit, data from Partner 12). It is known (Kerjean, Richoux 2003) that in this type of cheeses (Semi-Hard Cheese Types) salt level over 1% are a powerful means to prevent butyric acid fermentation.

- The cheese maker of partner 7 visually observed the presence of white moulds on the surface of low-salt Bout d'Fagne cheeses. This presence is probably due to *Pennicillium camemberti*, the growth of which is normally repressed by low activity of water in plain smear cheeses with normal salt level.

3.3 Odour and aromas

Salt reduction did not modify clearly the smelling and aromatic richness of the different cheeses (Trappist, Bout d'Fagne, Annex 2). It is likely that the limited salt reduction in Trappist cheese (-30%) and in Bout d'Fagne cheese (-10%) leading to a not-significant modification of proteolysis, lipolysis, amino acids and fatty acid catabolism (as observed in deliverable 1.2) does not cause any difference in terms of aroma and odour which can be measured clearly by the expert panel.

4. Conclusion

The salt reduction (20-30%) was systematically perceived by the consumers in the four cheese types.

The other consequences on cheese texture, odour or aromas were globally slight and variable, depending on the type of cheese.

The only exceptions were the acid taste and pungency that is reduced with the decrease of salt rate.

The slight differences observed by sensory analysis on low-salt Raclette, Brie and Trappist cheese should not have a negative impact on their acceptability's level.

In case of Bout d'Fagne, the evolutions linked to the salt reduction were very low comparatively to the variability of cheese-making, so it is difficult to prove the same fact.

The salt-level reduction did not modify the smelling and aromatic richness of Bout d'Fagne and Trappist Cheese.

Standard Trappist cheese with normal salt level tended to have a higher aromatic richness than the low-salt cheeses.

The main fact concerning low-salt Bout d'Fagne is the presence of some cheese with the mould *P. camemberti*, which is considered by professionals and by consumers as an important defect. The objective of the next task 1.4 is to look for solution to this defect.

Concerning low salt Trappist cheese, cheese pieces with abnormal holes were found by partner 12 during winter. Some of these cheeses were characterized by an abnormal butyric taste (identified by empirical tasting) and more than 50 mg/100g of butyric acid. The objective of the task 1.4 is to propose a solution for this defect.

5. References

JR Kerjean, R Richoux (2003) Manuel du Salage en Fromagerie, Editions Arilait, Paris, 69 pages

TP Guinee, BT O'Kennedy (2007) Reducing Salt in Cheese and Dairy Spreads in Reducing Salt in Foods: Practical Strategies, Woodhead PTD edEd., London

ISO Standard 8589 (2007) Sensory analysis -- General guidance for the design of test rooms

6. Annex: detailed results

ANNEX 6.1. DETAILED RESULTS OF THE QUANTITATIVE PROFILE

For each type cheese, sensory profiles were performed.

The multidimensional analysis PCA presented in figure 1, pointed out that sensory differences between the three variants of salt rate were more or less important depending on the type of cheese.

On the left, a graph represents the first PCA plan where the main parameters of taste and aroma are projected as arrows organising the map.

On the right, the different cheeses which were analysed are represented on the same map and marked as “standard” for cheeses with no salt reduction, “SaltReduct1” for cheeses with about 20% salt reduction and “SaltReduct2” fort cheeses with about 30% salt reduction.

A comment is given in blue for each graph.

The three variants of Bout d’Fagne cheeses were not really differentiated in the plan.

For the Brie and Trappist, we observed more evident differences between the products: Those differences concerned principally the Standard in relation to the two other variants with reduced salt level.

For the Raclette, the three variants were relatively well differentiated.

The discrimination between products was due to the differences on salt taste, but we also pointed out differences on texture and taste, which were variable, depending on the type of cheese considered.

For the Raclette, the differences were grounded on a taste less acid, less pungent, with a dry fruits aroma more intense and a more flexible texture, more free-running and melting for the variants with salt reduction.

Others taste differences contributed to differentiate the variants of cheeses: the variants with salt reduction seemed to be less bitter, less rancid, with a more pronounced milk aroma, and concerning the aspect, with a more yellow color and more holes.

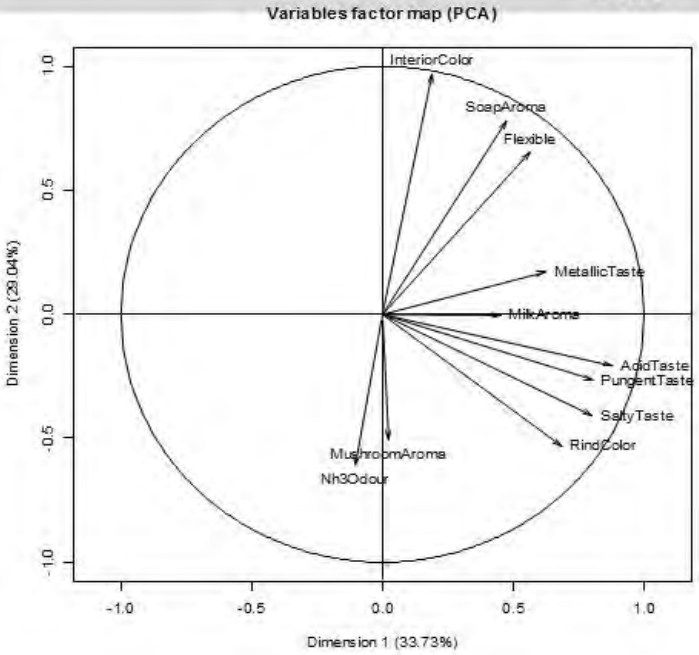
For the Brie, the differences were principally grounded on taste characteristics: a taste less salty, less acid, even less pungent with a metallic aroma less intense for the variants with salt reduction. The rind's colour was more yellow for the Standard.

Concerning the Bout d'Fagne we did not point out any characteristics whose evolution could be linked to the cheese's salt rate. The three variants were very close one to other and we could not identify an axis of differentiation related to the salt level.

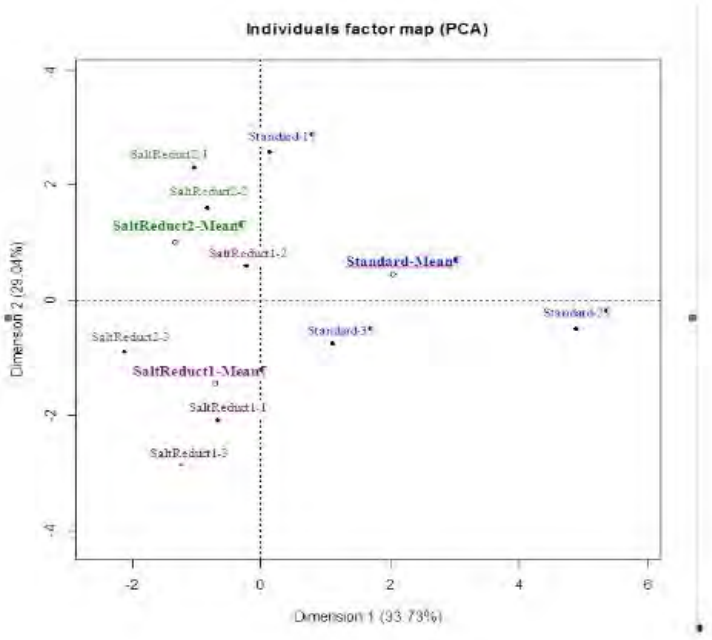
For the Trappist, the differences were due to a taste less salty, less acid, less bitter, but more sweet, with a texture more flexible, more fat and less dry. The evolutions seemed also to correspond to a texture less firm and more melting with aromas of butter and dry fruits more intense.

Overall, among the measured sensory characteristics we couldn't point out any common criteria, between the different types of cheese, whose evolution could be linked to the cheese's salt rate, excepted salty taste. The bitter and acid taste seemed to be strengthened with the increase of salt rate, and this is verified in 3 cases on 4. On the other hand we did not highlight common differences between the different types of cheese, in terms of texture

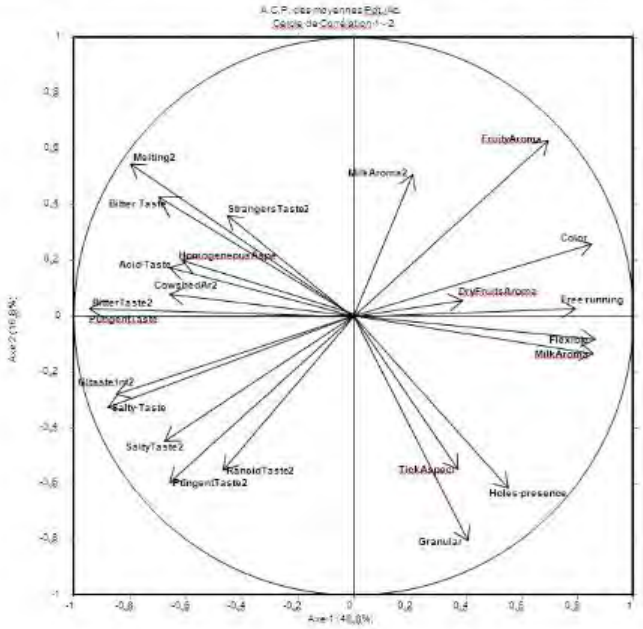
Brie



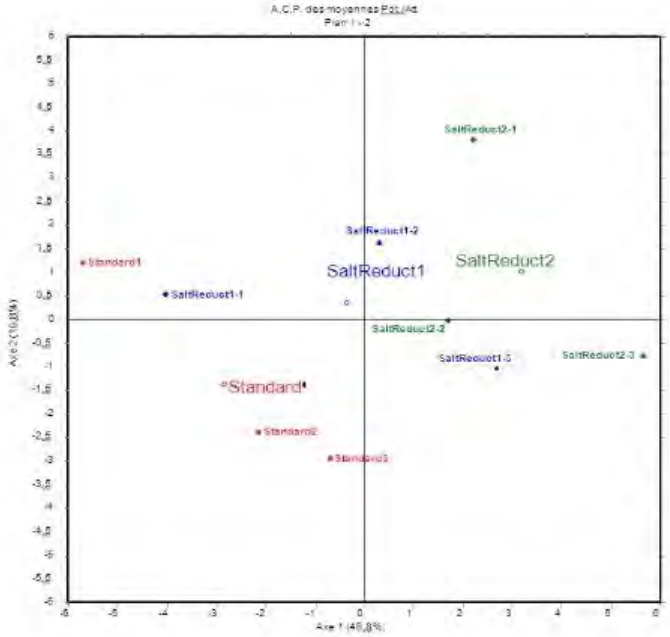
Standard cheeses are less acid, less piquant, less salty,



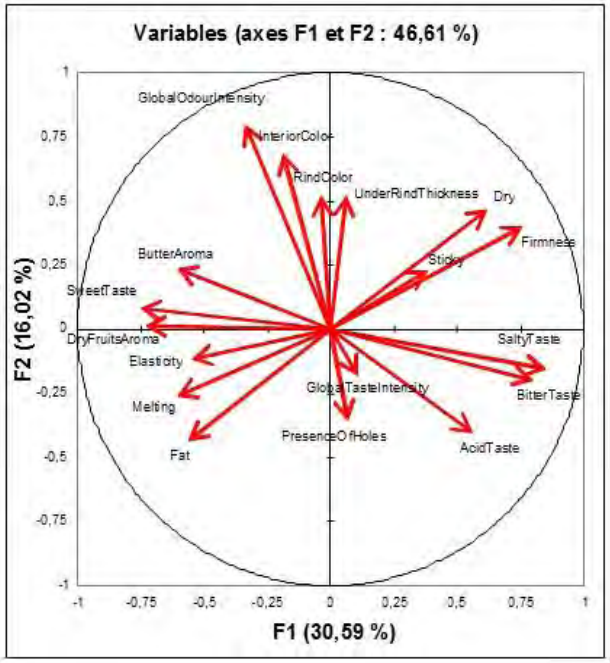
Raclette



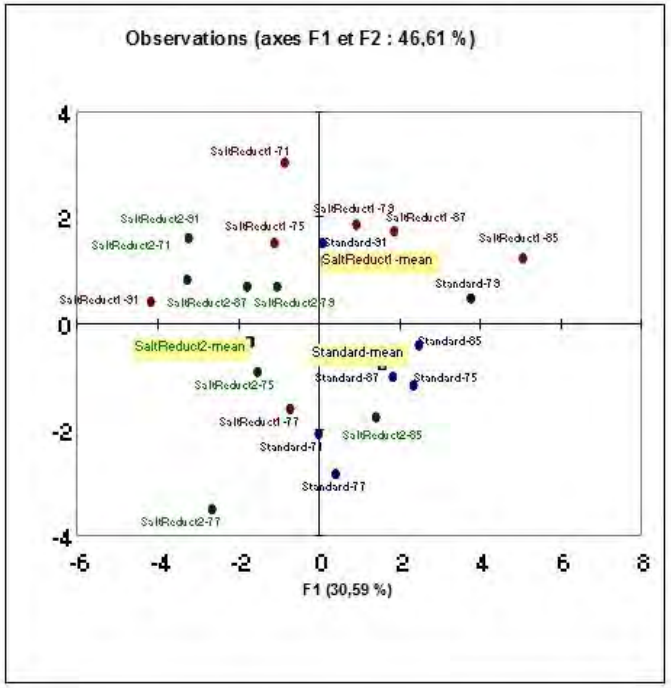
Standard cheeses are less salty, less acid, less « fruity », less piquant, less stretchable, less elastic, less melty.



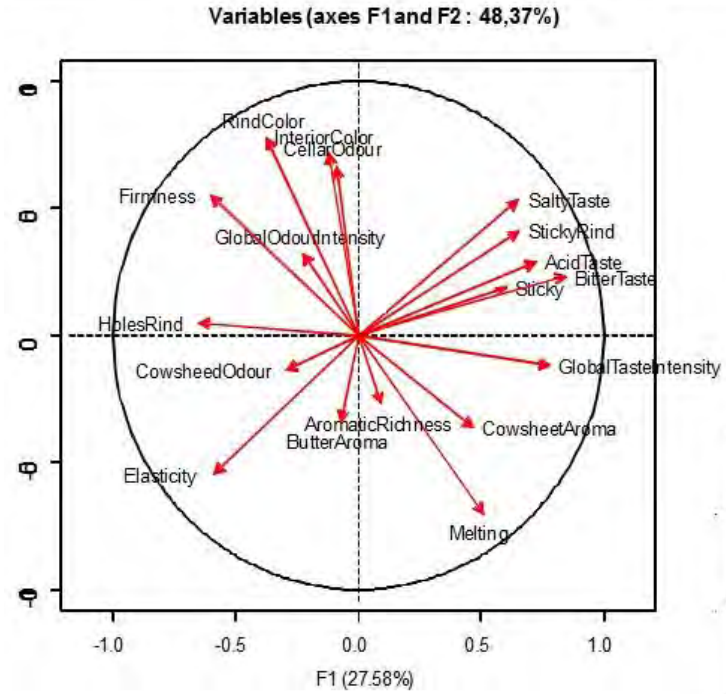
Trappiste cheese



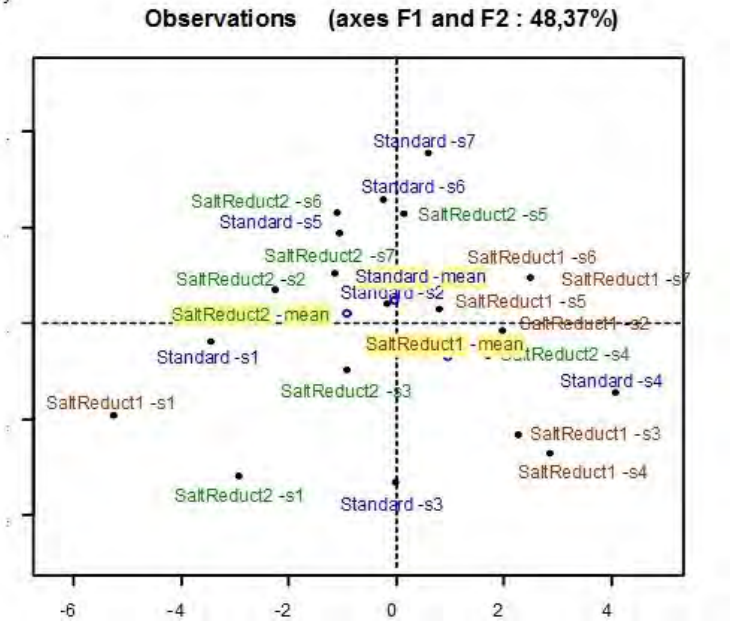
Standard :
more salty, more acid, more bitter, texture drier, less melty, less « fatty »



Bout d' Fagne



No significative differences



ANNEX 6.2 DETAILED RESULTS OF THE QUALITATIVE PROFILE

1. Aromatic richness

This part was realized with the characterization results, analysing how many attributes were quoted in the list by an assessor (in average). The smells and flavor richness can so be defined as the average number of quotations indicated by a subject, for a given cheese. The analysis was conducted from the data obtained for every studied cheese (the repetition is considered as a second individual).

Table 2: Comparison of average number of quotations

	Average number of quotations			
Bout d'Fagne	**Standard**	**SaltReduct1**	**SaltReduct2**	
Odours	5,5	5,4	5,5	Pvalue = 71%
Aromas and flavours	6,2	6,3	6,2	Pvalue = 60%
Trappist	**Standard**	**SaltReduct1**	**SaltReduct2**	
Odours	4,9	4,9	5,0	Pvalue = 46%
Aromas and flavours	5,7	5,5	5,4	Pvalue = 5.6%

As we can see in table 2, this analysis did not highlight a significant difference between the smells and the aromas/flavours richness of the three variants of Bout d'Fagne and Trappist cheese. The salt-level reduction did not modify the smelling and aromatic richness.

But in case of Trappist cheese, the analysis highlighted a tendency to the difference on aromas and flavours richness. The Standard cheese tended to have a higher aromatic richness than the cheeses with a reduction of the salt level (SaltReduct1 and SaltReduct2)

2. Aromatic profile

The aromatic profile corresponds to the frequency of quotation of olfactory attributes and aromas attributes for every variant of cheese (accumulation of 7 cheese makings).

These attributes were classified in a decreasing frequency order, until the level 10 % (level of background noise), to identify the smell or aromatic dominance for each cheese.

Besides, the comparison of number of quotations for each attribute, between the three cheeses was used to identify the impact of salt reduction on each olfactory note and aroma note of the cheese. Finally, for the simultaneous visualization of smell and aroma attributes, we did a Principal Component Analysis (PCA) performed on the attributes which obtained more than 10% of quotations (21 quotations for one of the three variant at least).

These analyses allowed us to highlight the following characteristics for every type of cheese

For the Bout d'Fagne cheese, the aromatic dominance were the same for each variant of Bout d'Fagne, Standard or SaltReduced cheese :

1. For the odours: The odours quoted by more of 40% of the assessors were "foot" and "cowshed". The others important odours were: some "dairy" notes as "butter", "boiled milk", "fresh cream", "fresh milk" and "whey" and other "strong" attributes as "animal" and "blue cheese" (quoted by more than 20% of the assessors). Then the attributes "butyric", "baking yeast", "ground", "cumin", "garlic", "grassy", "cooked cabbage" and "cooked onion" (quoted by more than 10% but less than 20% of the assessors).
2. For the aromas/flavours: the major aroma was "butter". The others important aromas were some "dairy" notes as "boiled milk", "fresh cream", "fresh milk", "whey" but also "pungent", "foot", "beef flavour Boutillon", "cowshed", "cooked onion", and "blue cheese" (quoted by more than 20% of assessors) and some other notes as "animal", "grassy", "vinegar", "cooked cabbage", "lemon" or "ground", "propionic", "pepper", "cumin", "garlic", "baking yeast" (quoted with a frequency of more than 10% but less than 20%)
3. The only differences we could observe were for attributes only quoted by less than 20% :
4. "Cellar odor" (P= 1.1%): the Standard variant had a more intense cellar odour than the SaltReduct1 and the SaltReduct2 variants. The salt reduction seemed to have an effect on this attribute: the more the salt-level was important, the more the attribute "cellar" was quoted by the assessors
5. "Walnut aroma" (P=3,6%): the Standard variant of Bout D'Fagne cheese presented a more intense walnut aroma than the two other variants (SaltReduct1 and SaltReduct2).
6. Considering simultaneously all the characteristics did not permit to see some differences between products.

For the Trappist cheese, this study showed that the aromatic dominance were the same for each variant of Trappist cheese. Nevertheless we highlighted differences on majors

aromas with the characteristics “pungent” more quoted for the standard and the characteristic “fresh cream” more quoted for the salt reduced variants.

3) For the odours: The odours quoted by more of 40% of the assessors were “dairy” notes: “butter”, “boiled milk” and “fresh cream”. The others important odours were “whey” and the “apricot/peach” attribute (quoted by more than 20% of the assessors) and some other notes as “hazelnut”, “hay”, “foot”, “animal” cowshed” or “grassy” (quoted by more than 10% but less than 20% of the assessors).

4) For the aromas/flavours: the most quoted aromas (more than 40% of assessors) were “butter”, “boiled milk”, “whey”, and “pungent” for the Standard, and “fresh cream” for the salt reduced variants. The others important aromas were “fresh milk”, but also “lemon” (quoted by more than 20% of assessors) and some other notes as “hazelnut”, “ground” or “hay” (quoted with a frequency of more than 10% but less than 20%).

5) We could note some tendencies to differentiate the odour of the three variants, but only for attributes quoted by less than 20% of assessors: on the "Cooked onion odour" (P=6.5%), the product SaltReduct2 tended to have a more intense smell of cooked onion than the Standard and SaltReduct1. We saw another tendency for "Straw odour" (P=14.9%): the product SaltReduct2 tended to obtain most quotations for this attribute.

In terms of aromas, the differences were numerous and concerned principally the minors aromatic notes:

- “Beef flavour Boutillon” (P=0.02%): the salt reduction seemed to have an important effect on this attribute. Indeed, the Standard variant is the one which obtain the most numerous quotations, followed by the SaltReduct1 (with an intermediate number of quotations) and the SaltReduct2 (with the less numerous quotations).
- “Grassy” (P=4.3%): the two cheeses with lower salt levels had a less intense grassy aroma than the Standard cheese. It is though important to underline that the SaltReduct1 was qualified as less grassy than the SaltReduct2 without any significant difference.
- “Pepper” (P=0.2%): the salt reduction had an effect on the pepper aroma; the less the cheese contained salt, the less it was associated to the “pepper” attribute.
- “Rancid” (P=1.1%): as for the previous attributes, the Standard cheese obtained the most numerous “Rancid” quotations, followed by the SaltReduct1 and the SaltReduct2. The difference was smaller between the two “SaltReduct” variants than with the Standard.
- “Vinegar” (P=0.2%): for this attribute, the two variants SaltReduct1 and SaltReduct2 had a similar number of quotations, but this number was highly inferior to the Standard cheese.

- But some of those differences concerned dominant aromatic notes :

- “Pungent” (P<0.01%): the Standard Trappist cheese was more strongly associated with a pungent flavour than the two salt reduced variants. The salt reduction seemed to decrease the pungency of cheese.
- “Lemon” (P=2.1%): the Standard and SaltReduct1 variants were more often associated to the lemon aroma than the SaltReduct2 variant.
- “Fresh cream” (P=3.4): the two Trappist cheese with salt reduction were more often associated with the “fresh cream” aroma.
- “Butter” (P=11.2): the butter aroma tended to be increase with salt reduction.

- However, we can remind some differences underlined by the Principal Component Analysis on aromas (figure 3)
- For the odours: the 3 variants are very close one to the others.
- For the aromas/flavours: Cheeses were lined up along the first axis, according their salt rate, with a biggest gap between the standard and the two variants, than among the two variants. This positioning is principally due to the following aromas: pungent, beef flavour, lemon and vinegar. Besides, three aromas seemed to distinguish the standard: grassy, pepper and rancid. On the contrary, the salt reduced cheeses were more associated with the flavours: “fresh cream”, “butter” or acetaldehyde (especially for saltreduct2).

Table 1: Quotation frequencies of the most used olfactory attributes: Bout d'Fagne

Quotation frequencies of the most used olfactory attributes for Bout d'Fagne					
Standard		**SaltReduct1**		**SaltReduct2**	
Foot	54%	Foot	57%	Foot	53%
Cowshed	46%	Cowshed	50%	Cowshed	51%
Boiled milk	34%	Boiled milk	38%	Animal	37%
Fresh milk	34%	Animal	29%	Fresh milk	31%
Animal	30%	Fresh milk	29%	Boiled milk	31%
Fresh cream	28%	Whey	27%	Butter	25%
Blue cheese	24%	Butter	24%	Fresh cream	25%
Butter	24%	Fresh cream	22%	Whey	25%
Whey	20%	Blue cheese	20%	Blue cheese	21%
Cellar	18%	Baking yeast	19%	Baking yeast	18%
Butyric	16%	Grassy	17%	Ground	17%
Baking yeast	16%	Ground	16%	Cumin	16%
Ground	15%	Cumin	15%	Butyric	14%
Cumin	14%	Garlic	14%	Grassy	13%
Garlic	14%	Cooked Onion	12%	Cooked Onion	13%
Grassy	13%	Butyric	11%	Cooked cabbage	12%
Cooked cabbage	13%	Cooked cabbage	11%	Garlic	10%
Cooked Onion	12%	Pear	11%	Beef flavour Boutillon	10%

Table 2: Quotation frequencies of the most used olfactory attributes: Trappist

Quotation frequencies of the most used olfactory attributes for Trappist					
Standard		**SaltReduct1**		**SaltReduct2**	
Butter	61%	Boiled milk	56%	Butter	61%
Boiled milk	54%	Butter	54%	Boiled milk	51%
Fresh cream	40%	Fresh cream	48%	Fresh cream	47%
Fresh milk	33%	Fresh milk	32%	Fresh milk	38%
Apricot/Peach	25%	Whey	28%	Apricot/Peach	27%
Whey	24%	Apricot/Peach	24%	Whey	23%
Hazelnut	17%	Foot	16%	Hazelnut	18%
Hay	15%	Hay	14%	Grassy	16%
Foot	14%	Hazelnut	14%	Cooked Onion	15%
Crust of bread	12%	Cowshed	12%	Hay	14%
Animal	11%	Acetaldehyde	11%	Garlic	14%
Cowshed	11%	Animal	11%	Straw	14%
Grassy	11%	Grassy	11%	Foot	12%
Flower	11%			Flower	11%
				Acetaldehyde	11%
				Animal	10%
				Cowshed	10%

Table 3: Quotation frequencies of the most used aroma and flavour attributes: Bout d'Fagne

Quotation frequencies of the most used aromas and flavours attributes					
Standard		**SaltReduct1**		**SaltReduct2**	
Butter	53%	Butter	53%	Butter	54%
Pungent	39%	Boiled milk	39%	Pungent	36%
Fresh cream	38%	Pungent	38%	Boiled milk	35%
Boiled milk	33%	Fresh cream	34%	Fresh cream	32%
Blue cheese	31%	Fresh milk	32%	Cowshed	29%
Fresh milk	29%	Foot	30%	Beef flavour Boutillon	28%
Foot	29%	Cooked Onion	30%	Foot	28%
Whey	26%	Blue cheese	26%	Fresh milk	28%
Beef flavour Boutillon	25%	Beef flavour Boutillon	26%	Blue cheese	25%
Cowshed	25%	Whey	26%	Whey	24%
Cooked Onion	25%	Cumin	25%	Cooked Onion	23%
Baking yeast	22%	Cowshed	22%	Cumin	22%
Garlic	21%	Propionic	20%	Pepper	22%
Cumin	19%	Garlic	19%	Baking yeast	19%
Pepper	16%	Baking yeast	19%	Cooked cabbage	16%
Propionic	16%	Pepper	18%	Garlic	16%
Animal	13%	Animal	15%	Propionic	15%
Grassy	13%	Grassy	15%	Grassy	14%
Vinegar	13%	Vinegar	13%	Vinegar	14%
Cooked cabbage	12%	Lemon	13%	Animal	13%
Lemon	11%	Cooked cabbage	12%	Lemon	13%
Ground	11%	Ground	11%	Ground	13%
Walnut	11%			Crust of bread	10%
Crust of bread	10%				

Table 4: Quotation frequencies of the most used aroma and flavor attributes: Trappist

Quotation frequencies of the most used aromas and flavours attributes					
Standard		**SaltReduct1**		**SaltReduct2**	
Butter	53%	Butter	57%	Butter	62%
Pungent	49%	Whey	47%	Boiled milk	52%
Whey	47%	Fresh cream	47%	Fresh cream	49%
Boiled milk	45%	Boiled milk	46%	Whey	46%
Fresh cream	38%	Lemon	33%	Fresh milk	30%
Lemon	33%	Pungent	30%	Pungent	25%
Fresh milk	26%	Fresh milk	29%	Lemon	23%
Vinegar	18%	Hazelnut	18%	Hazelnut	18%
Beef flavour Boutillon	16%	Cooked Onion	13%	Acetaldehyde	15%
Hazelnut	15%	Walnut	12%	Apricot/Peach	13%
Rancid	15%	Beef flavour Boutillon	12%	Ground	12%
Ground	11%	Cooked cabbage	11%	Cooked cabbage	11%
Grassy	11%	Hay	11%	Hay	11%
Pepper	11%	Ground	11%	Walnut	11%
Cooked Onion	11%				
Hay	10%				
Blue cheese	10%				

PCA map on Trappist cheese aromas- Principal plan

(35.76+11.88 = 47.64% of the total variability)