# TeRiFiQ

**Project no. 289397**

Combining Technologies to achieve significant binary Reductions in Sodium, Fat and Sugar content in everyday foods whilst optimizing their nutritional Quality

**Start date of project**: 1 January 2012
**Duration of project**: 4 years
**Call**: FP7-KBBE-2011-5
**Theme:** KBBE.2011.2.3-05 [Processed foods with a lower salt, fat and sugar content]
**Funding Scheme**: Collaborative Project (small or medium-scale focussed research project targeted to SMEs)

# Deliverable D7.2
# TeRiFiQ infosheet

***Abstract:*** *main research results provided by the scientific partners into an easy readable form to be disseminated.*

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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) | |

TeRiFiQ infosheets summarize the main research results into an easy readable form. They are mainly addressed to industrial and scientific stakeholders.

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**INFOSHEET** nr.1

TeRiFiQ

Reducing Salt, Fat & Sugar in Everyday Foods

# TeRiFiQ infosheet

## *Flavour release and perception changes induced by fat and sodium reduction in cheeses*

### *Needs & Challenges*

Flavour perception is a multimodal sensation involving olfactory, taste and trigeminal stimulations generated by food components. These perceptions can interact between them through perceptual interactions. Moreover, the flavour compounds can interact with the matrix components, leading to release and/or retention phenomenon.

Thus, changes in fat and/or salt content in cheeses may induce changes in flavour release and perception. In low salt and fat cheeses, lower taste perception may be compensated by other perceptual modalities. The challenge is to evaluate in what extents it is possible to play on the phenomena described above to try to decrease fat, salt and sugar content in food without negative impact on perception and acceptability.

### *Improvements of food processing through RTD activities*

Model cheeses varying in fat and salt content, pH at renneting and aroma composition were tasted in order to evaluate the ability of fat and salt associated aromas (butter and sardine, respectively) to compensate for salt reduction and fat in low salt cheeses products. The modification of salt and fat content as well as pH value induced changes in texture perception**.** In addition, a significant saltiness enhancement and fat content perception enhancement was induced by the congruent aroma only.

Concerning real cheeses, a significant enhancement of saltiness intensity was induced by sardine aroma and butter aroma but the later in a lower extent while a limited effect was observed with the blended aroma. A significant fat perception enhancement was induced by blended aroma while butter aroma alone has no significant effect on fat perception and sardine aroma alone has a significant masking effect on fat perception.

These findings confirmed that the use of aromas can be an efficient strategy to compensate the reduction of fat and salt content in dairy products. However, the products' composition and structure influenced flavour perception and especially odour-induced perception enhancement but these effects appeared to be complex.

Product composition and structure (fat, salt and pH at renneting) also influenced aroma release (*in vitro* approach), which however depends on the nature of the aroma: the more hydrophobic compounds are less sensitive to variations in fat content and more sensitive to variations in pH and therefore to the products structure. The salt release kinetic during *in vitro* chewing was also influenced by the composition and structure of the products. Indeed, beyond salt content which determined the amount of salt released, fat content and the pH at renneting modulated the salt release kinetic.

### *How can producers benefit in practice*

Aroma addition alone or in combination with other strategies can assist the food industry ***when reformulating low-sodium and low-fat foods while maintaining consumer acceptability***. This follows the recommendations by the public national and international health organisations.

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**INFOSHEET nr. 2**

TeRiFiQ
Reducing Salt, Fat & Sugar in Everyday Foods

# TeRiFiQ infosheet

## *Flavour release and perception changes induced by fat and sodium reduction in emulsions*

### *Needs & Challenges*

Flavour perception is a multimodal sensation involving olfactory, taste and trigeminal stimulations generated by food components. These perceptions can interact between them through perceptual interactions. Moreover, the flavour compounds can interact with the matrix components, leading to release and/or retention phenomenon.

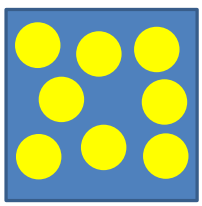
The use of emulsions is an efficient strategy to lower fat content in several foods. However, the composition and structure of the emulsion can influence the availability of both taste and aroma compounds, and flavour perception. The challenge is to evaluate in what extents it is possible to play on their structure and composition to try to decrease fat and salt content in food without negative impact on perception and acceptability.

### *Improvements of food processing through RTD activities*

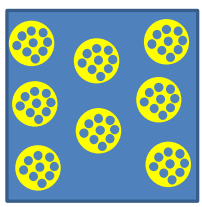
Single (OW) and double emulsions (WOW) varying in composition were designed in order to evaluate the influence of their composition and structure on salt release, mouth-coating and, fat and salty perception. Two single emulsions varied in fat/water content and three double emulsions made from the single emulsion with the higher fat content, contained 0, 4 and 8% salt in the inner water phase. No significant difference for mouth coating and salt release was observed according to the different emulsions, suggesting that salt in the inner phase is not released in the mouth. Concerning perception, neither fat content perception nor saltiness perception were significantly affected by any change in structure and composition of the emulsions. This suggests that 30% fat and salt content reduction can be done in emulsions without any detrimental effect on sensorial characteristics of the food. The ability of fat and salt associated aromas (butter and sardine, respectively) to compensate for salt reduction and fat was tested in a single (OW) and a double (WOW) emulsion. The emulsion type did not influence saltiness perception. In addition, the aromatization of emulsions did not show a significant saltiness enhancement.

Regarding fat content perception, it was perceived with a higher intensity in the double emulsion compared to the single but the aromatization of the emulsions did not seem to enhance fat content perception in emulsions, whatever their structure.

These findings indicate that the use of double emulsion seems more appropriate for fat reduction in foods by replacing fat by emulsions. However, in this case, the use of aromas to compensate for the reduction of fat and salt does not seem to be an efficient strategy in foods reformulated with emulsions, though the addition of aromas increased the aroma dimension of emulsions.

Single emulsion OW



Double emulsion WOW

### *How can producers benefit in practice*

Emulsions can be used to reduce fat content in foods. However, this strategy should be coupled with other strategies than the addition of aromas to compensate for salt and fat content perception in order to ***follows the recommendations by the public health organisations***. In double emulsions, salt should be in the outer phase to impact saltiness perception.

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**INFOSHEET** nr. 3

TeRiFiQ

Reducing Salt, Fat & Sugar in Everyday Foods

# TeRiFiQ infosheet

## *Industrial scale production of pizza sauces and sweet creams with reduced fat and salt or sugar*

## *Needs & Challenges*

Obtaining and producing high quality products with low salt, low fat and low sugar content is increasingly requested by consumers. Because of increased awareness following information, advertisements and advice from nutritionists in Romania, consumers are seeking out these healthier products.

The challenges of this project are to create tomato sauces for pizzas, and sweet creams for confectionery products without modifying their taste profile and to limit any increase in price of the final products to less than 5% (on basis of feedback from consumer tests). The quality and food safety of modified sauces have to be the same as the standard product

## *Improvements of food processing through RTD activities*

Low-fat pizza sauce and low-fat sweet cream were obtained by using double emulsions. The fat content of the sauce and cream were reduced by 30% (target of project was reached).

All ingredients used for the new sauces were purchased on basis that their specification was checked and had a declaration of conformity.

Low salt pizza sauces (20% less salt) were obtained by using a salt replacer.

Low sugar content was reached by using Stevia extract for replacing some of the sugar (30% reduction). Similar sensorial properties were confirmed by an expert trained panel and several consumer tests.

Quality control of sauces and creams were tested by external laboratories (ANSVSA Targu-Mures Romania), the microbiological safety of modified sauces were also checked, according to Romanian legislation.

Reformulated sauce and cream were produced according to HACCP principles and internal verifications were controlled by authorities (on the basis of an annual control plan).

## *How can producers benefit in practice*

Because of the demand from consumers to purchase products with reduced fat, sugar and salt, the result of the trials within this project can be used for developing a new range of products. It cannot replace the actual range (because of financial issues), but helps the manufacturers to produce these special products, which have a benefit for consumers' health.

A good advertisement will draw a prospective customer's attention towards these low-fat, low-salt and low-sugar products. This what every company wants in a positive way, showing them to be a producer who takes care about their customers' health and offers to them ***an alternative to standard pizzas or cakes***

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**INFOSHEET** nr. 4

TeRiFiQ
Reducing Salt, Fat & Sugar in Everyday Foods

TeRiFiQ infosheet

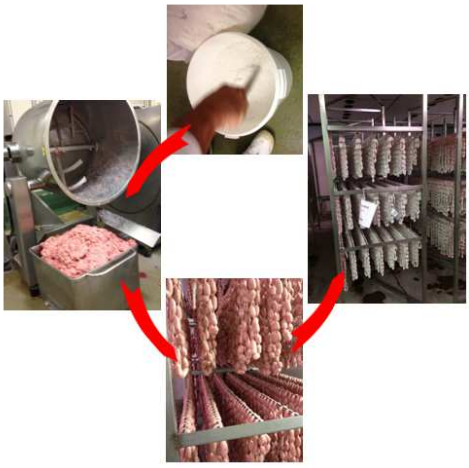
# *Industrial scale production of cured sausages with reduced salt and fat*

## *Needs & Challenges*

Current market trends and various international market consulting companies, including the Nielsen market research support in Europe and America, show that 50% of consumers are willing to pay more for a product with "healthy" features.

For public health issues, dry fermented sausages have a fat and salt content that need to be reduced. But these ingredients are mainly responsible to flavour, texture and microbial security of food. So, the challenges of this project are to validate new strategies by recipes and process to optimize industrial reduced salt and fat cured sausages.

A lot of strategies were tested during the project to achieve ambitious nutritional goals



## *Improvements of food processing through RTD activities*

The implementation of research activities leads to the demonstration that new strategies are therefore efficient to reduce simultaneously the salt and saturated fatty acid contents in dry sausages.

For snacks of fuet the better tests in terms of texture and taste are with oil and fiber addition + modified KCl + flavour enhancer (yeast extract). 70% of SFA reduction and 35% of salt reduction can be obtained.

For chorizo the better tests in terms of texture and taste are with fat emulsion + modified KCl + natural flavouring. 60% of SFA reduction and 40% of sodium reduction can be obtained.

The sensorial evaluation of these reduced products performed first for expert judges and consumers shows that new formulations are very close to the control and there aren't significant global differences between them.

99% of consumers affirm that they would buy the reduced snacks of fuet.

89% of consumers affirm that they would buy the reduced chorizo.

Finally, the microbial safety of new cured sausages was validated by the challenge test approach.

**Nutritional claimed achieved according to European Regulation**


## *How can producers benefit in practice*

The 21st century lifestyle and consumption in a context of increasing longevity of the population and radical reduction of physical work against technological sedentary lifestyle, results in an increasing demand for healthy and functional foods that contribute to the prevention of cardiovascular diseases and obesity in specially in developed countries where are concerned for these diseases. Thus, the TeRiFiQ activities on dry sausages provides meat companies with ***solutions to offer healthier products for consumers, without losing on product authenticity.*** Yield of reduced test at industrial scale is a little bit lower than control, however, it could be concluded that reduced products at industrial scale are affordable because ***consumers are willing to pay more price*** for these kind of products. Still we don't have market data, the commercial conclusions after ANUGA's trade fair are that is a real innovative concept with an excellent taste. The new range of cured represents an important contribution to healthy nutrition.

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**INFOSHEET** nr. 5

TeRiFiQ
Reducing Salt, Fat & Sugar in Everyday Foods

# TeRiFiQ infosheet

## *The influence of the salt reduction on the overall maturation process and the general sensory quality/acceptability of semi-hard cheese and soft cheese with moulds*

## *Needs & Challenges*

When the cheese salt level is reduced, the higher activity of water aw flavour lipolysis and proteolysis which are the main ripening mechanisms. In bibliography, the reduction of salt by 30% in cheese seems to be possible for cheddar cheese. The increase of lipolysis in low salt soft cheese with moulds is known as a bad flavour hazard. The increase of aw in low salt semi-hard cheese increases the butyric acid fermentation hazard, which is the main defects in cheese due to Clostridium tyrobutyricum. Salt reduction is known to pose problems for soft cheese with smear.

Overview:

a) Cheese = 9 mt Europe; 40% of European milk; 18 kg/y/h;

b) Cheese = 5% of the total salt intake in Europe but 7% in France, Greece, Italy;

c) Salt in cheese = 1-2g/100g (from 0.4 % to 2% depending on cheese variety) (0.4% in Emmental).

d) Cheese is a fermented product: Lactic + propionic in Emmental Lactic + Yeast + Mould Camembert

Key questions:

• How the main mechanisms are modified by the salt reduction?

• What is the nature and the intensity of quality modifications due to salt reduction? and what is acceptable by consumer?

• How to correct these modifications?

• How to combine the salt reduction and the improvement of fat by increase of Unsaturated Fatty Acids (UFA)

## *Improvements of food processing through RTD activities*

This higher proteolysis was confirmed but the results obtaiend in commercial low salt (-30%) Trappist, experimental Emmental, Brie and Raclette showed that imrovement is lower that it could be forecast. On the contrary the lipolysis is higher in low salt (-30%) Brie cheese. The light improvement of protelolysis could be interesting for texture (in particulat in Trappist or Raclette). The increase of lipolysis must be observed in details for lipolysis could be a source of soapy or piquant undesirable aromas. Cheese salt reduction by 30% is perceived by the consumers. Consequences on texture, aromas and odour are slight. In Raclette and Trappist cheese the aroma and texture seems a little improved. In low salt Brie cheese we do not noticed soapy or piquant flavour. In winter, we observed clearly a butyric acid fermentation in low salt Trappist cheese (>60 mg/100g of butyric acid) due to the insufficient repression of Clostridium tyrobutyricum in the cheese body during maturation, leading to bad taste, blowing and serious defects. In BoudFagne cheese, the salt reduction led to the presence white moulds (Penicilium camembert) which are an important defect for this type of cheese.

Generally, the lowering of salt content in cheese leads to matured product which are accetable by the consumers but, in some case, the higher activity of water causes serious defects (butyric defect in hard cheeses, presence of moulds on soft cheeses) which must be corrected by a mo dification of technological parameters.

## *How can producers benefit in practice*

We observed defects in Trappist (semi hard cheese) and Bou de Fagne (soft cheese with smear) and wished to correct them. The question of purchase intent of consumers was answered before marketing low salt Trappist cheese.
Adding lysozyme from white egg is the main way to struggle against butyric acid fermentation linked to Clostridium tyrobutyricum in low salt Trappist cheese. This modification seems to be necessary and allows Orval cheese factory to market low salt Trappist. The consumers' purchase intent is lower (-10%) for low salt Trappist, even if the flavour is not modified. This could be linked to the traditional image of this product, generally made in abbeys. A lot of technological modifications were studied in order to improve the quality of low salt Bou de Fagne cheese without any satisfying results. These results show that the salt reduction must be studied cheese type by cheese type. In some case (Soft cheese with smear) the possibility of salt reduction seemed not practicable. The salt reduced cheese are present on the market.

**Generally the reduction is -25 or 30%. It is a good market opportunity for cheese industry.**

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**INFOSHEET** nr. 6

TeRiFiQ
Reducing Salt, Fat & Sugar in Everyday Foods

# TeRiFiQ infosheet

## *Evaluation of nutritional quality, sensory performance and consumer acceptance of muffins and madeleines*

## *Needs & Challenges*

Bakery products with reduced fat and sugar content" addresses technological and sensory issues related to the binary reduction of fat and sugar in model bakery products by combining two different technological approaches for fat reduction with one technological approach for sugar reduction to achieve a simultaneous reduction of fat and sugar by up to 25% while maintaining product quality, as follows:

- Multiple emulsions (fat reduction) combined with sugar replacement by natural, high potency sweeteners (sugar reduction);
- Cryo-crystallised fat (fat reduction) combined with sugar replacement by natural, high potency sweeteners (sugar reduction)

The model products chosen comprise of sponge cakes, muffins, cakes, pastries and/or pound cake which are bakery products widely consumed in the European Union and are a significant source of both dietary fat and carbohydrate intake.

## *Improvements of food processing through RTD activities*

MUFFIN: Fat and sugar amount reduced of 25% each. Muffin recipe was reformulated by using inulin (Frutalose SFP) as sugar replacement in order to achieve the targeted reduction level. The production of the muffins was up-scaled in order to allow for sensory testing and consumer acceptance testing. The nutritional quality of the muffin reduced by 25% fat and 25% sugar did not improve very much compared to a full fat and full sugar muffins. Since inulin was used as sugar replacer, 2 kcal/gram of inulin were added to the muffin. However, the addition of inulin increased the fibre content of muffins considerably. The sensory properties of these fat and sugar reduced muffins were determined by a trained panel in Norway from NOFIMA by using five reformulated muffins (reference muffins, nutritionally improved plain muffins and nutritionally improved chocolate muffins). MADELEINES: In order to improve texture properties of Madeleines which corresponds to consumer acceptance, optimizations in formulations of Madeleines were conducted by French team Adria. Two methodologies were tested, namely pre-hydration of fibres and the adjustment of the viscosity. The shelf life of reformulated Madeleines reduced in fat and sugar content were determined for a period of 6 months during which the spoilage, hygroscopic and textural aspects were investigated.

## *How can producers benefit in practice*

MUFFIN: No significant differences were found in sensory perception between the plain reference muffins and nutritionally improved plain muffins. For the muffins with milk chocolate, small, significant differences were observed for the attributes juiciness, vanilla odour and sour flavour between the reference chocolate muffin and the nutritionally improved chocolate muffin. Consumers were not able to distinguish between the nutritionally improved muffin and the full fat and full sugar references. **Simultaneous reduction of 25% sugar and 25% fat in commercial muffins is possible by partial replacement of sugar and fat with inulin while maintaining technical, organoleptic and hedonic properties**. MADELEINES: Madeleines with reduced sugar content and with good sensory, functional and technological properties were developed using modifications of the Madeleine aroma to enhance sweetness perception. Stepwise gradual reduction over time: "Health by stealth" **10% sugar and 40% fat reduction possible (muffins); Sugar and fat replacement by inulin; 25% sugar and 25% fat reduction possible (muffins); Odours to enhance taste and flavour; Sugar and fat reduction possible while optimizing flavour (madeleines)**

February 2016
**INFOSHEET** nr. 7

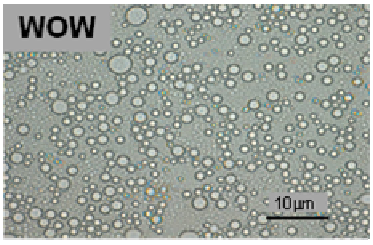
# TeRiFiQ infosheet

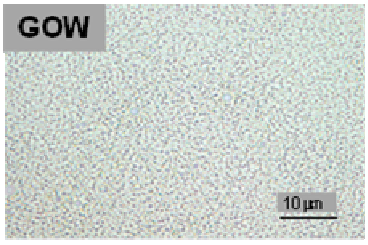
## *Use of double emulsion in combination or not with other reformulation strategies to lower salt, fat and sugar in sauces and industrial implementation of the reformulated sauces*

## *Needs & Challenges*

The main aim of the project was to achieve binary reductions in fat, salt or sugar. The primary goal of this workpackage was to apply multiple emulsion technology to reduce the fat content in sauces. The key issue with WOW emulsions is stability, and the one associated with changes in salt and sugar is the stability to gradients in osmotic or chemical potential. This is because the salt / sugar content of the $W_1$ water droplets is fixed during homogenisation, but the osmotic potential of the outer $W_2$ aqueous phase may change during processing, particularly where in reduced salt or sugar formulations. Therefore methods were developed to improve the stability of WOW emulsions to osmotic / chemical stress, and the effect of salt and sugar replacers on the stability of these emulsions.






## *Improvements of food processing through RTD activities*

All of the WOW emulsions were found to be sensitive to osmotic stress, for example, the W1 droplets would shrink and disappear if the salt or sugar concentration of the W2 phase was higher than W1. This would have a detrimental effect on the effectiveness of the fat reduction. Therefore methods were developed to improve the resistance of the W1 droplets to osmotic stress. The best approach that we found was to transform the W1 droplets into a gel, thus they would mechanically resist swelling or shrinkage under osmotic or chemical stress. Two approaches were developed which could be used in a range of foods. . Firstly using an alginate based polymer, which requires the presence of calcium to form a gel. Here, a $CaCl_2$ solution was added to the emulsion during the first homogenisation stage, this allowed the gradual incorporation of calcium into the W1 droplets, promoting gelation. The other method was to use a carrageenan based polymer which required heat to gel, often, the heat generated during homogenisation was sufficient to promote gelation. Different salt replacement strategies were studied for a tomato sauce based product. These included yeast extract, micronized salt, modified potassium chloride and the addition of garlic flavour and herbs to enhance the saltiness perception, but these latter strategies were only appropriate for use in pizza sauce type products due to the negligible impact on the overall flavour of the product. Sugar replacement was required for a sweet cream topping type product. Here, a 15% reduction in sugar was achieved by replacing some of the sugar with a stevia extract. The viscosity of the tomato sauces remained constant for the duration of the shelf life of the product, suggesting no breakdown in structure.

## *How can producers benefit in practice*

The outputs of this work provided preliminary protocols for the production of reformulated real food products (tomato sauce for pizza and sweet creams for cakes). To maintain the stability of the GOW structure during processing of real foods and positive sensory attributes compared to the standard recipe. Based on these results, it **appears that consumers enjoyed the reformulated products,** and some consumers would even be prepared to pay a little more, when considering the quality and health benefits. **Educating certain sectors of society** as to the added health benefits of reducing salt, fat and sugar in foods may have an impact of the cost of manufacture, and ingredients and processes that enable the reduction may actually be more expensive, and although **some consumers may be willing to pay a little more, others are not.** The other challenge is the current **limitation on the use of PGPR** as an emulsifier. However, there is ongoing research looking at other methods to produce multiple emulsions using food ingredients, but the processing is more complex and expensive. Some manufacturers would be willing to use PGPR where permitted, but others were not.

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**INFOSHEET** nr. 8

TeRiFiQ
Reducing Salt, Fat & Sugar in Everyday Foods

# TeRiFiQ infosheet

## *Industrial production of cooked sausages with decreased fat and salt content*

## *Needs & Challenges*

The main objective of this task was to implement and transfer knowledge obtained during laboratory tests into the production process of cooked sausages to improve the nutritional quality of the products. Hot-boned pork and different types of emulsifiers were tested in small-scale production. The purpose of using hot-boned meat was to increase firmness and binding of proteins. and fat were the two factors only which were tested. However, the effect was smaller than expected so hot-boned meat was not tested in full-scale production. The tested emulsifiers gave off-flavour in the sensory evaluation of the sausages. Therefore, the new emulsifiers were not used in the industrial test production either. That means sodium

## *Improvements of food processing through RTD activities*

Sausages from five different nutritionally improved recipes were made at Leiv Vidar's plant. Total salt content was lower in these batches compared with Leiv Vidar's reference sausage. In addition, some of the sodium was replaced with potassium and three recipes had less fat than the reference. The trained sensory panel at Nofima evaluated the nutritionally improved sausages, and the reference sausage listed in Table 1. The sensory panellists were selected and trained according to recommendations in ISO 8586:2012 General guidelines for the selection, training and monitoring of selected assessors and expert sensory assessors, and ISO 13299:2003 General Guidance for establishing a sensory profile. A list of 16 descriptive attributes were agreed by the assessors and used in the study. For nine of the attributes there were significant ($p<0.05$) differences between the six sausages. As shown in Figure 1 the reference sausage was clearly different from the other sausages, while the five nutritionally improved products were evaluated as almost identical. The main differences were related to texture and saltiness. It is possible to reduce these differences by minor adjustments in the commercial recipe, and still obtain a reduction in sodium and fat content. This shows that samples with relatively large variation in sodium and fat content could be similarly perceived.

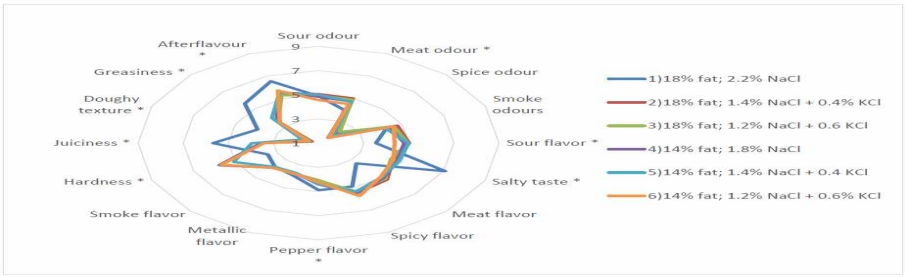


Figure 1. Spider web diagram of sensory attributes for sausages.

## *How can producers benefit in practice*

It is a general challenge for the EU population to reduce consumption of salt and fat. **In sausages, both salt and fat are necessary ingredients,** in addition to lean meat and binders. Salt has a technological function by improve binding of water to meat proteins and thereby the viscosity of the batter during production. In the final product it will **also influence texture, and of course saltiness when consumed.** Similarly, amount and type of fat selected in the recipe will also effect processing and sensory perception. **Technically, there is no problem to reduce sodium and fat by 50%**. However, to do it without changing textural and sensory perception of the product is a big challenge. By decreasing salt content in batter cooking loss will increase when total salt content is less than 2%. **20 - 30% of sodium can be substituted by potassium without affecting the sensory properties.** It is possible to reduce total salt content to 1.8%, of which NaCl is 1.2% and KCl is 0.6%. This means sodium content is reduced by 40% relatively, when compared with the reference product. **Sodium content can be decreased without significant change in sensory perception.**