Flavour release and perception in reformulated foods

Towards a better understanding

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Background

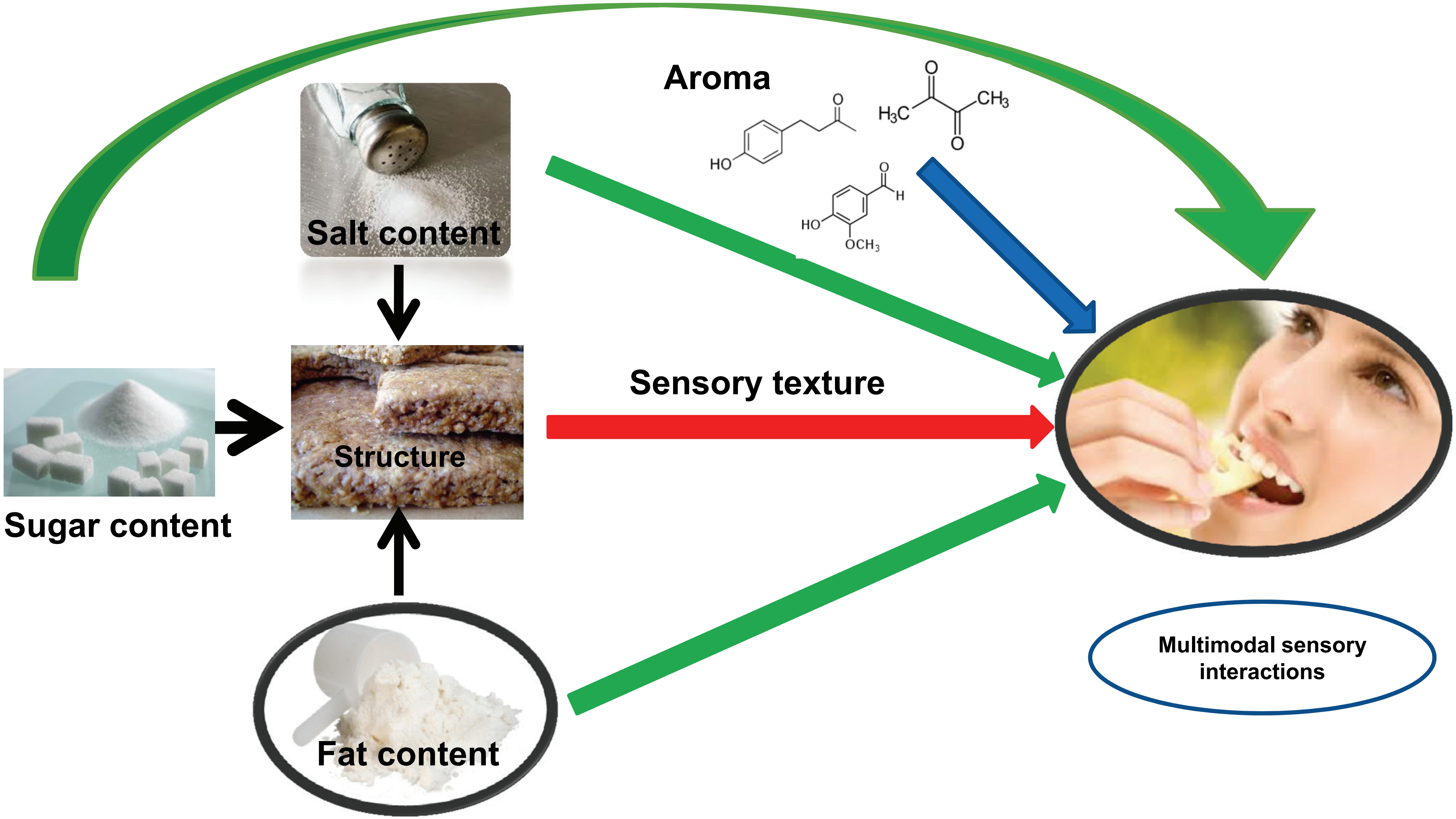
- Many solutions have been proposed to decrease salt in foods but most of them imply drastic changes in the matrix structure and /or composition in order to increase the quantity of salt released in the mouth or at least modify the release kinetic. Another implication is a significant addition of compounds which are not present in the original product.

- The bases of our hypothesis are

Interactions between aroma, taste and texture shape the overall food flavour perception.

These complex sensory interactions can be used as a lever to compensate the loss in flavour in reformulated foods with a low content in fat and sodium or sugar.

Texture-taste-aroma interaction on flavor perception



Objectives

The **objective** is to fully characterize sensorially the products and its reformulation in order to determine which variable from the subjects and the products drive the sensory perception (related to fat, salt and sugar) the most.

More precisely:

- To evaluate the capacity of aroma compounds to enhance saltiness, sweetness and fat perception in food systems varying in composition

- to better understand the mechanisms of aroma and taste compound release during mastication, leading to flavour perception . In particular, how the different texture and structure of food influence flavour perception during eating.

Approach, Methods, Role of partners

- **Approaches**

- Perceptual interactions

- In vivo flavour release and temporal perception

- In vitro flavour release

- **Methods**

- Sensory evaluation

(Profiles, Temporal Dominance of Sensations)

- In nose-PTR-MS

- Chewing simulator

- ^{23}Na NMR

- **3 Partners**

INRA (FR)

(Cheeses and emulsions)

NIZO (NL)

(Sausages and Muffins)

WUR (NL)

(Sausages and Muffins)

Enhancement of salt and fat content perception by odours in model cheeses

METHODS

24 model cheeses prepared according to a full-factorial design:

- 2 fat levels (F1=20%, F2=40%).
- 2 salt levels (S1=0.5%, S2= 1.5%).
- 2 pH levels (P1=5.0, P2=6.2).

Each sample was flavoured with either:

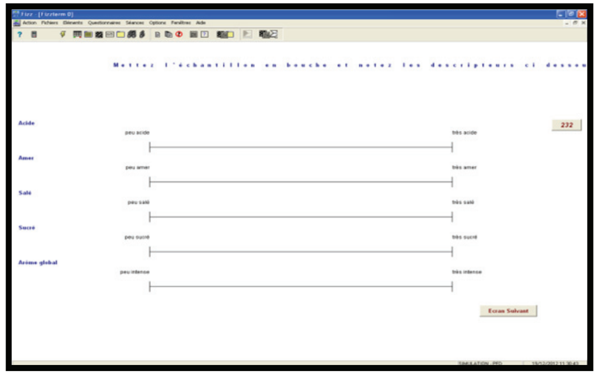
- ➢ sardine aroma (associated to salt).
- ➢ butter aroma (associated to fat).
- ➢ not flavoured (control).

Sensory evaluation procedure
31 panelists (21 women, 10 men)

salty,
sweet,
sour,
bitter,
elasticity,
firmness,
moistness,
melting,
granularity,
perceived fat content

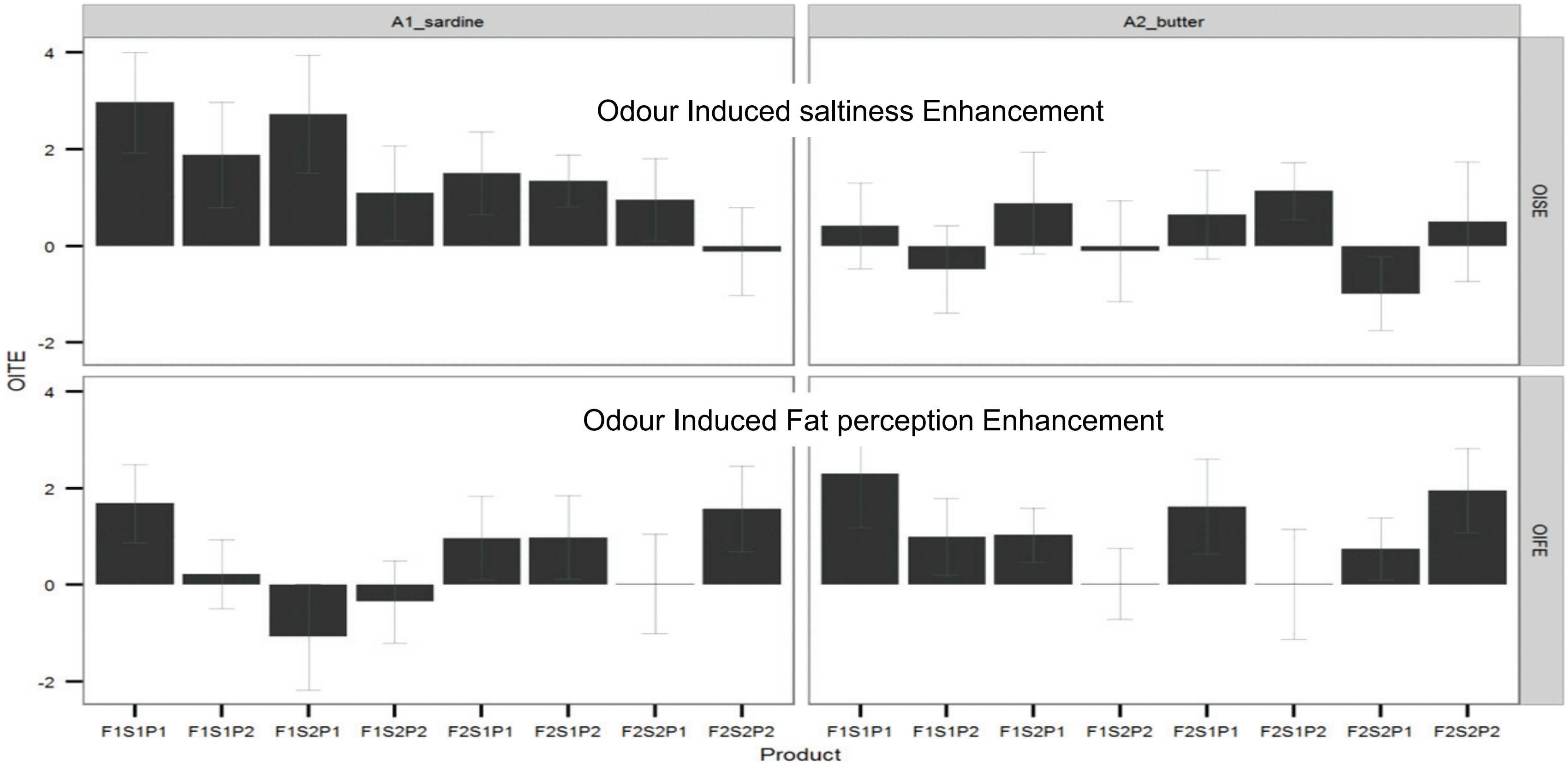
and liking (specific session)

Sensory attributes (linear scales 1-10, FIZZ)



RESULTS

- Odor Induced Taste Enhancement (OITE)



- Model cheeses flavored with sardine aroma showed enhanced salty taste, particularly for low fat and low salt
- Model cheeses flavored with butter aroma could be perceived more fat.

Effect of odorants for fat and sugar reduction compensation in muffins

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Methods

Aim: additional restoration of fat/sugar-related flavour and texture in binary-reduced muffins by the use of aromas

primary compensation (WP3):
Fat → WO
Sugar → short-chain Inulin

secundary (aroma) compensation (WP5):
Fat → volatile fat-related butter extracts
Sugar → 3(2)-furanone & Maltol

6 muffins x 2 aroma conditions (+/0) x 3 replicates

	Full fat	-40% fat	-58% fat (**70/30 WO)**
Full sugar	Reference	-Fat	
-15% sugar	-Sugar	-Fat/-Sugar	--F/-S + fat restoration
-30% sugar + **inulin**		-F/--S + sugar rest.	

→

↓ ↓

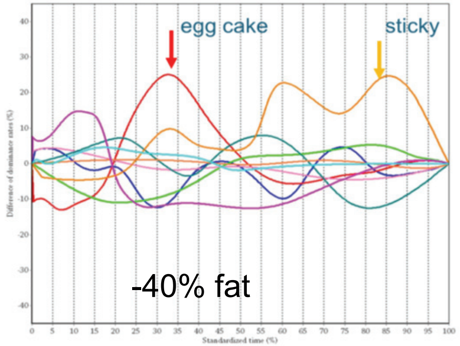
Temporal Dominance of Sensations (12 subjects)

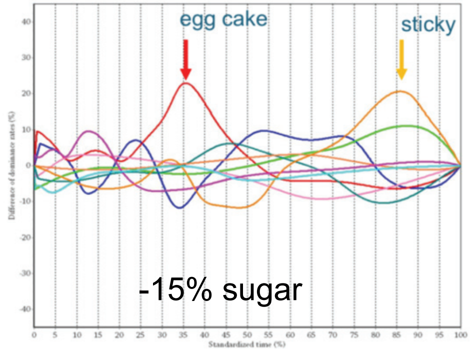
In-nose-PTR-MS
Measurement of release dynamics of volatiles

RESULTS

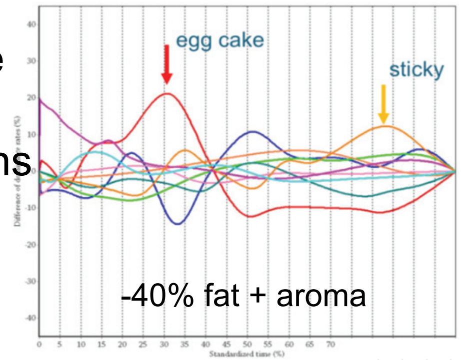
Comparison of TDS profiles between regular and mono/binary-reduced muffins and aromatized version thereof

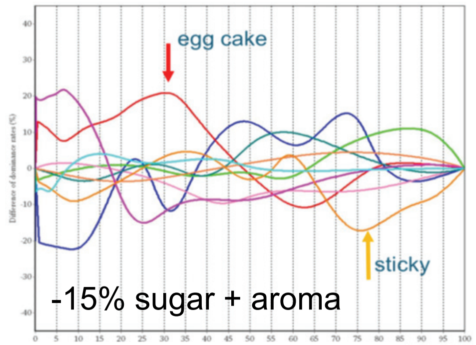
The early “Egg cake” and the late “Sticky” elevations both indicate that these attributes are more dominant in the regular muffin than in the reformulated ones.



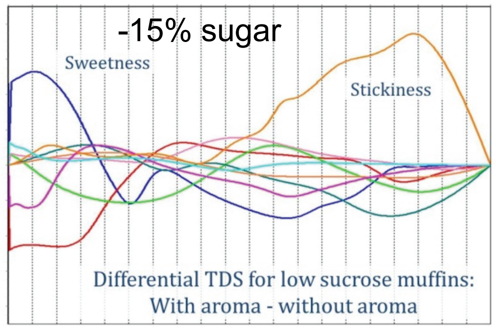


The restoration of “sticky” dominances by the aroma is clearly observed in mono-reduced fat muffins and in mono-reduced sugar muffins (overcompensated)
No restoration of egg flavour.





The compensation of lower sugar content with aroma results in enhancement of early sweetness and late stickiness.



Flavour release and temporal perception in dairy products

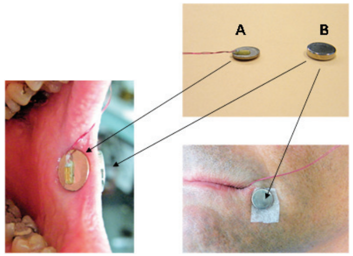
Flavour release and perception

In vivo approach

15 panellists (9 women/6 men)

Simultaneously measured

In-mouth salt release

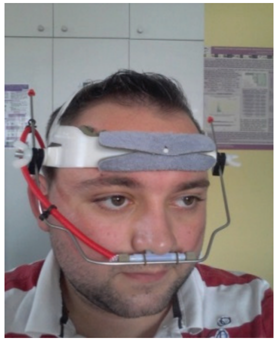


miniconductimeter

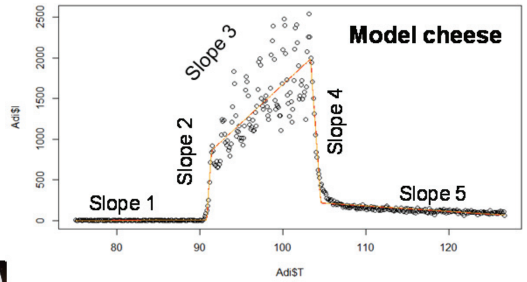
Temporal Dominance of Sensation

Rating of the dominant sensations during time

In-mouth aroma release

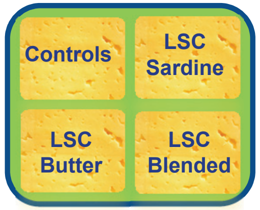


Slope 1 : baseline of aroma release
Slope 2 : aroma release at the beginning of product break down
Slope 3 : aroma release during chewing
Slope 4&5 : aroma release after chewing



Flavour release and perception

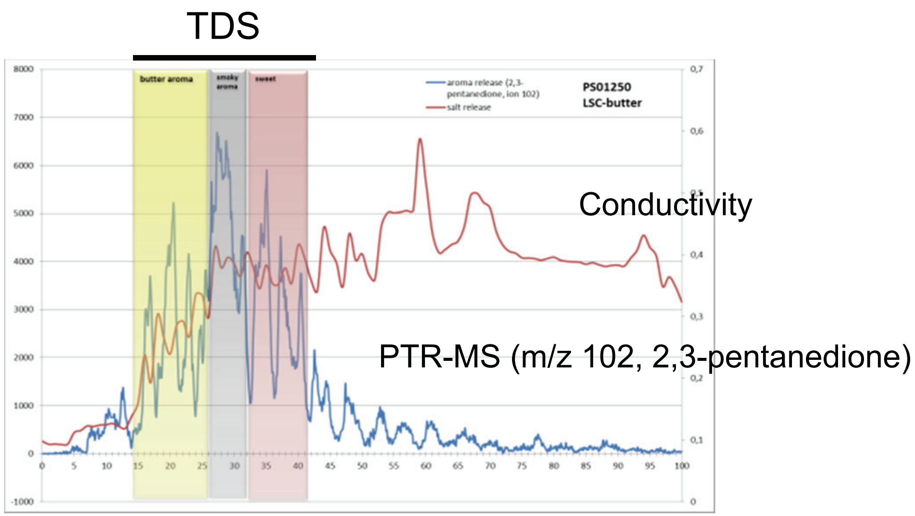
Example with real cheeses (Trappist,Orval)



Low salt cheese (**LSC**)
Regular salt cheese (**RSC**)

PTR-MS

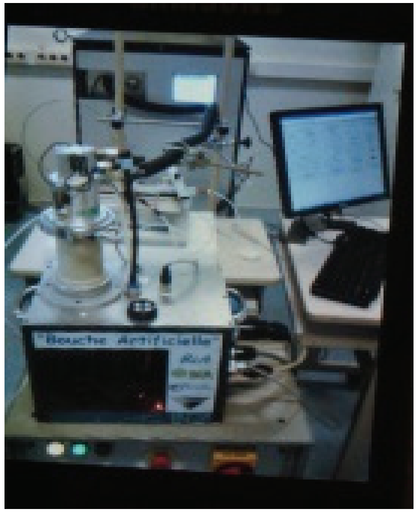
m/z 101 (hexanal),
m/z 102 and
m/z 119 (2.3-pentanedione),
m/z 117 (ethyl butyrate).

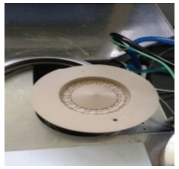


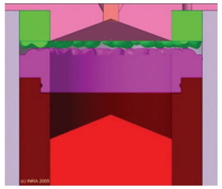
- In-mouth salt concentration remains high after food swallowing while in-nose odorant concentration does not.
- Kinetic of flavour compounds release is mostly in accordance with temporal sensory perception (TDS).

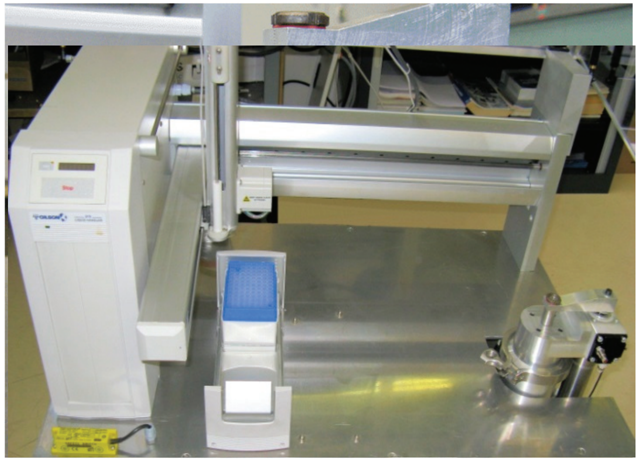
Flavour release and perception

In vitro approach (use of a chewing simulator)

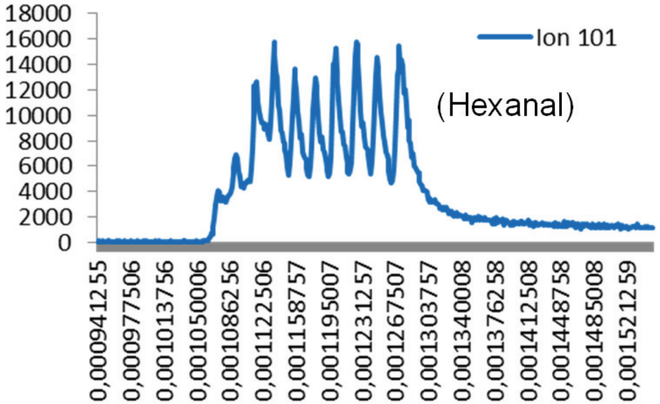




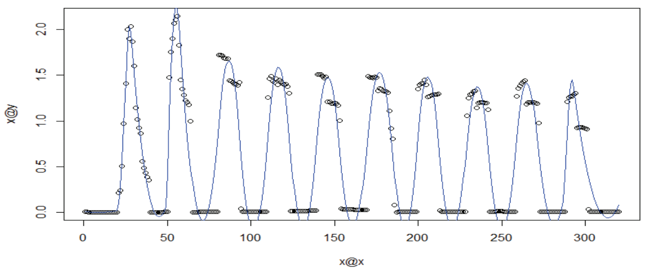




On line connection to PTR-MS



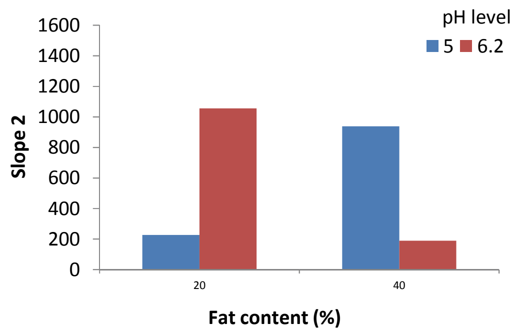
Conductivity measurement

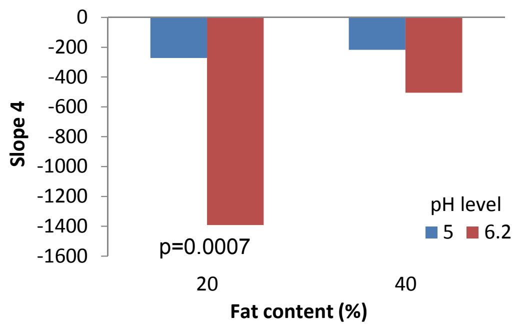


Flavour release and perception

Example with model cheeses

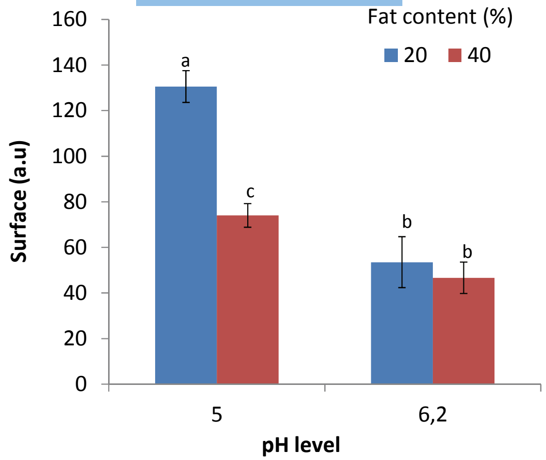
Hexanal release

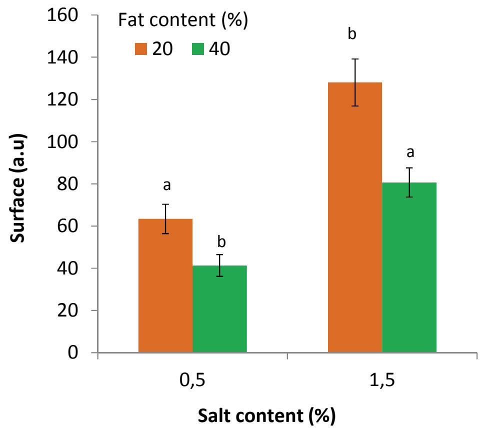




- Fat and pH influenced hexanal release at the beginning of product breakdown and after chewing.

Salt release





- A higher fat content limited salt release in low pH
- The higher level of salt release was observed in high salt content

During the course of release, hydrophilic compounds (pentanedione) was more released in comparison to the hydrophobic compounds (hexanal and ethyl butyrate), meaning that release could be linked to hydrophobicity of aroma and ingredients used.
The aroma and salt release behaviors were highly related to composition of model cheeses.

Flavour release and temporal perception in dry fermented sausages

Methods

Aim: influence of reformulation on flavour release and perception. Potentiality of odourants to compensate for taste perception

12 different fuets (DFS)

No odor	Full Na^+	-25% Na+ K^+ replaced
full fat	Ref	LowN
-30% fat	lowF	LowNF

Odor: Salt mix	Full Na^+	-25% Na+ K^+ replaced
full fat	Ref+S	LowN+S
-30% fat	lowF+S	LowNF+S

Odor: salt & fat mix	Full Na^+	-25% Na+ K^+ replaced
full fat	Ref+SF	LowN+SF
-30% fat	lowF+SF	LowNF+SF

Odorants: salt mix and fat mix (formulated according to bibliography)

In-nose-PTR-MS

Measurement of release dynamics of volatiles (eating)

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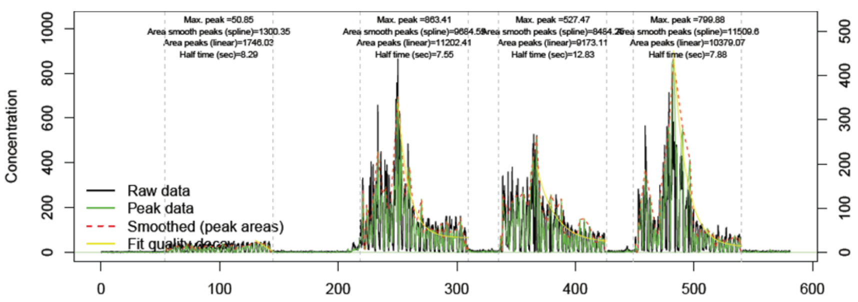


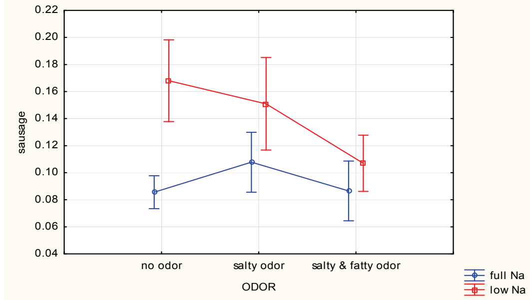
Temporal Dominance of Sensations (12 subjects)

Taste, aroma and texture attributes

Results

<u>Perception:</u> Na+ reduction compensation

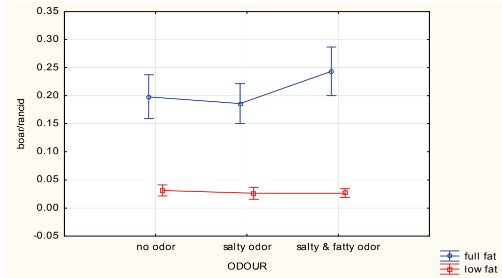
Partial sodium replacement by K^+ made DFS flavour more outspoken *meaty-sausage/like*. Aromas based on fat-metabolites and salty smelling aromas compensated this.



<u>Perception:</u> fat reduction compensation

Fat-reduction reduces *boar taint/rancid* notes of fuet DFS

The fatty odor mix (which includes fat-oxidation products) did not enhance *boar/rancid* in low-fat sausages, but to some extent in the full-fat sausages.



<u>Odorant release kinetics: effects Na+/fat reduction:</u>

Volatile release (varied log-P and vapor pressures) is affected by $Na^+ > K^+$ substitution and by fat reduction:

↓fat content and ↓Na+ content produces ↓release pulsation after swallowing (longer release half-times)

- ➢ aroma-release-specific Fat/Na mimics required.
- ➢ reformulated products may require adjustment of spice content

Summary of main findings & discussion

- **Conclusion**

- Aromas can be used to enhance taste perception in different kinds of food, but also to compensate texture perception defects.
  - However, the enhancement is highly dependent on the quality of the odourants and on the composition and texture of the foods.

- Concerning flavour release and perception, it is difficult to draw general conclusions as it seems to be rather specific of the food system tested.
  - In general, fat affects aroma release pulsation upon swallowing
  - However, in most of cases, it is dependent on the food structure and composition.
  - In other words, overall food composition should be considered to optimize (1) tastant and aroma release, and (2) the overall flavour of food.

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Summary of main findings & discussion

- **Perspectives**

Many perspectives can be drawn from these works:

- To better understand the effect of food composition on flavour release and temporal perception by integrating the action of saliva and changes in bolus structure during the consumption and after swallowing

- To improve in vitro systems to study flavour release and to develop combined sensors systems for taste compound detection

- To integrate these perceptual data in the development of further healthy reformulated products

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Thank you very much for your attention

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