Children's view on bakery products & sourdough

by Pauline Semeria, Camille Dupuy - Lesaffre International

CONTEXT

Children's appreciation of bakery products is very important to foresee the future bakery market. In order to better understand the place of bakery products in children's diet, we questioned them on eleven bakery goods: where and when did they consume these bakery products? Where did they purchase them? How much did they eat ? Further more, their representation of the healthy aspect of those bakery products is assessed by a projective mapping method using pictures of healthy and unhealthy goods.

Finally, a study focusing on sourdough breads is conducted to understand how each bread category is appreciated and described by children.

MATERIALS & METHODS

1. Place & moment of consumption

Consumers: 130 French children; 12-years-old

Test: Check-All-That-Apply

Protocol: a paper questionnaire with 10 pictures are shown to children to illustrate the place of consumption (in front of the TV, at sport, in the car, outside, at the canteen) and the moment of consumption (breakfast, lunch, after-school snack, dinner). Children are asked to tick the pictures that best illustrated their consumption mode of each bakery product studied.

Data processing: AFM on frequencies of quotation and Cluster Analysis.

2. Healthy characteristics

Consumers: 130 French children; 12-years-old

Test: Projective mapping

Protocol: 21 pictures are presented to children. 11 pictures illustrate bakery products and 10 illustrate other foods considered more healthy (vegetables, fruits, fish, …) or more unhealthy (french fries, mayonnaise, …). Children are asked to put all these pictures on a A3 sheet depending on their similarities, to circle the products they considere in a same group and name them using their own words.

Data processing: A PCA (spearman) on MDS table (children verbatim in additional variable) is followed by a Cluster Analysis.

3. Focus on sourdough bread consumption

Consumers: 65 French children; 5 to 15-years-old

Test: Consumer test and focus group

Protocol: in blind condition, children are asked about their knowledge of sourdough bread and their appreciation (without tasting). Then, they smell & taste a sourdough bread and describe it with their own vocabulary

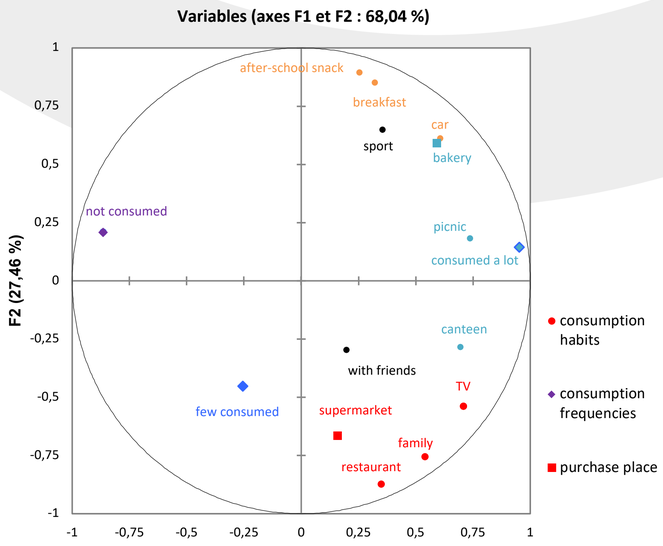
Data processing: Mc Nemar test

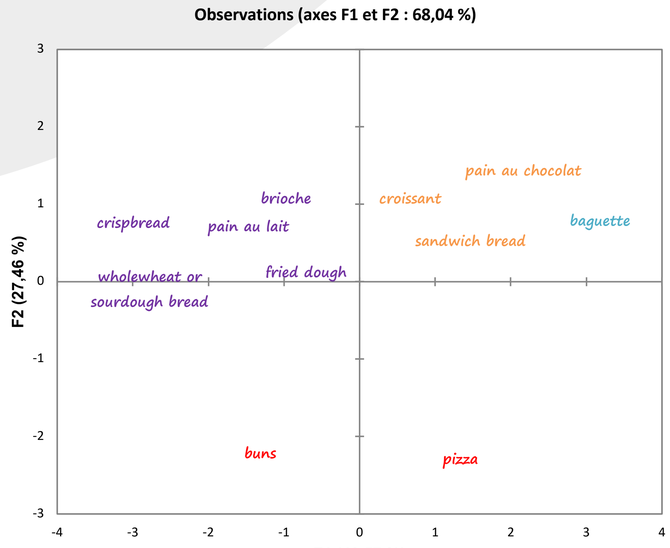
RESULTS

1. Place & moment of consumption

Products are clustered in 4 groups (see colours) that can be explained by consumption habits, frequencies and place of purchase. Axis 1 represents the level of consumption (from none to a lot).

Pizza and buns are bakery goods that are characterised by a consumption at restaurant, during family meal, in front of the TV and bought in supermarket. Fried doughs, crispbread, brioche and pain au lait are in the group of products least consume. Croissant, pain au chocolat and sandwich bread are consumed in the car, at breakfast and after-school snack. Baguette is apart and described as the most consumed, especially at the canteen or at picnic. Baguettes are mainly bought in craft bakeries.

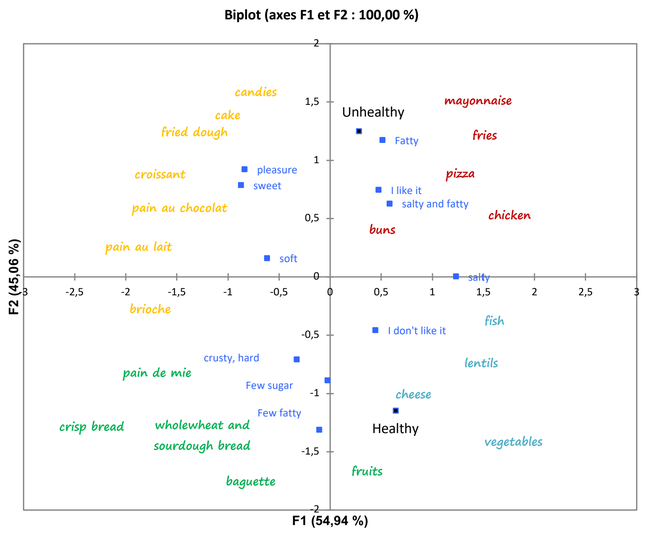




2. Healthy characteristics

Pain au lait, brioche, croissant, pain au chocolat are associated to cake and candies in a group that represents pleasure and sweetness.

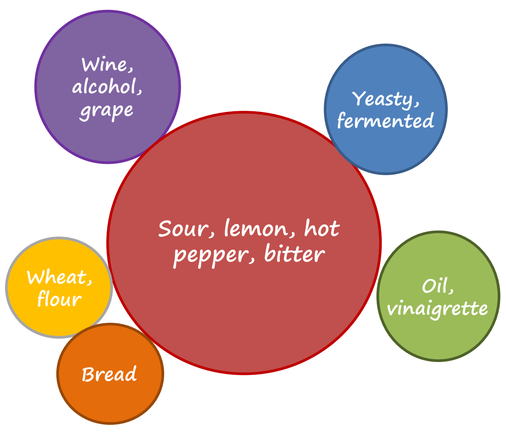
Pizza and buns are positioned in the salty, fatty, unhealthy group. It is appreciated and associated to fries and mayonnaise (junk food). Cheese, vegetables, lentils and fish are clustered in the healthy and dislike products. Baguette, sandwich bread and sourdough bread are associated to fruits in the "healthy, not sweet and fatty, crusty" group.



➔ *4 groups of products are shown (see different colours) and described by free verbatim used by children well described by the healthy / unhealthy axis :*

3. Focus on sourdough bread consumption

78% of children surveyed do not know what is a sourdough bread and 8% think that is a bread that rises by itself. When they smell or taste a sourdough bread, they significantly appreciate it : more than 60% declare they like it. They characterize the flavours of the crumb using 6 categories of verbatim represented in bubbles of differentes sizes (the size is proportional to the number of quotes). A majority perceived a sour taste associated in their mind to lemon, hot pepper & bitterness. They also describe it with an alcohol, raisin, wine aromas (fruity aroma of sourdough) with fermented & flour characteristics.



CONCLUSION

The baguette is the most consumed bread product and mainly consumed in school restaurants and outside (picnic). 12-years-old children have a clear view of bakery products and sort them in 3 categories: healthy, unhealthy and sweet products. In this classification, breads with sourdough are positioned in the healthy group with baguette, crispbread and sandwich bread. Children said that they do not consume a lot of sourdough bread even if 60% like it. They describe it as a sour, fermented, winy (related to fruity?) product. Further thought can be given to better communicate on sourdough and suggest other ways to introduce it to children (in school cafeterias for example).

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Combine yeast, bacteria & flours **to create new flavours**

by Pauline Semeria, Camille Dupuy, Benoit Demiselle, Emilie Bryckaert - Lesaffre International

CONTEXT

Bakers can use Starter sourdough in order to bring taste & acidity to bread. Depending on the flours used for sourdough fermentation & the type of microorganisms in the Starter, many taste combinations can be created.

Tests were carried out using 2 Lesaffre sourdough Starters with different ratios of yeast, homo- and heterofermentative bacteria. Both Starters contain a sourdough yeast strain and differ in the type of bacteria present. Starter 1 is composed of *L. plantarum* (homofermentative) and *L. brevis* (heterofermentative) in a 50/50 ratio; whereas Starter 2 contains *L. brevis* in higher percentage. Sourdough fermentations are conducted on 4 flours (rye T170, wheat T55, stoneground T80 and buckwheat T198) at 30°C during 18h for Starter 1 and 20h for Starter 2. 30% sourdough is added to the final dough of a standard wheat bread recipe (2h first fermentation + 2h final proofing). The present work aims at demonstrating this using 2 types of starters of different microflora characteristics, in sourdough fermentations on different flours. The breads obtained from baking these sourdoughs are then evaluated for their physico-chemical and organoleptic profiles in order to highlight the specifities of each final bread product.

MATERIALS & METHODS

Instrumental method

pH of bread crumb

TTA (mL) for 10g of crumb : addition of NaOH 0,1M to reach pH = 6,6

Descriptive sensory method : Q.D.A.

Expert panelists: 13 people

Protocol: Quantitative Descriptive Analysis (Q.D.A.) is managed

Data processing: PCA and Cluster Analysis

Dynamic sensory method : Time Intensity

Expert panelists: 8 people; 2 repetitions

Protocol: panelists are asked to quote sour intensity during all the tasting period. Standardized sample size.

RESULTS

Analytical results

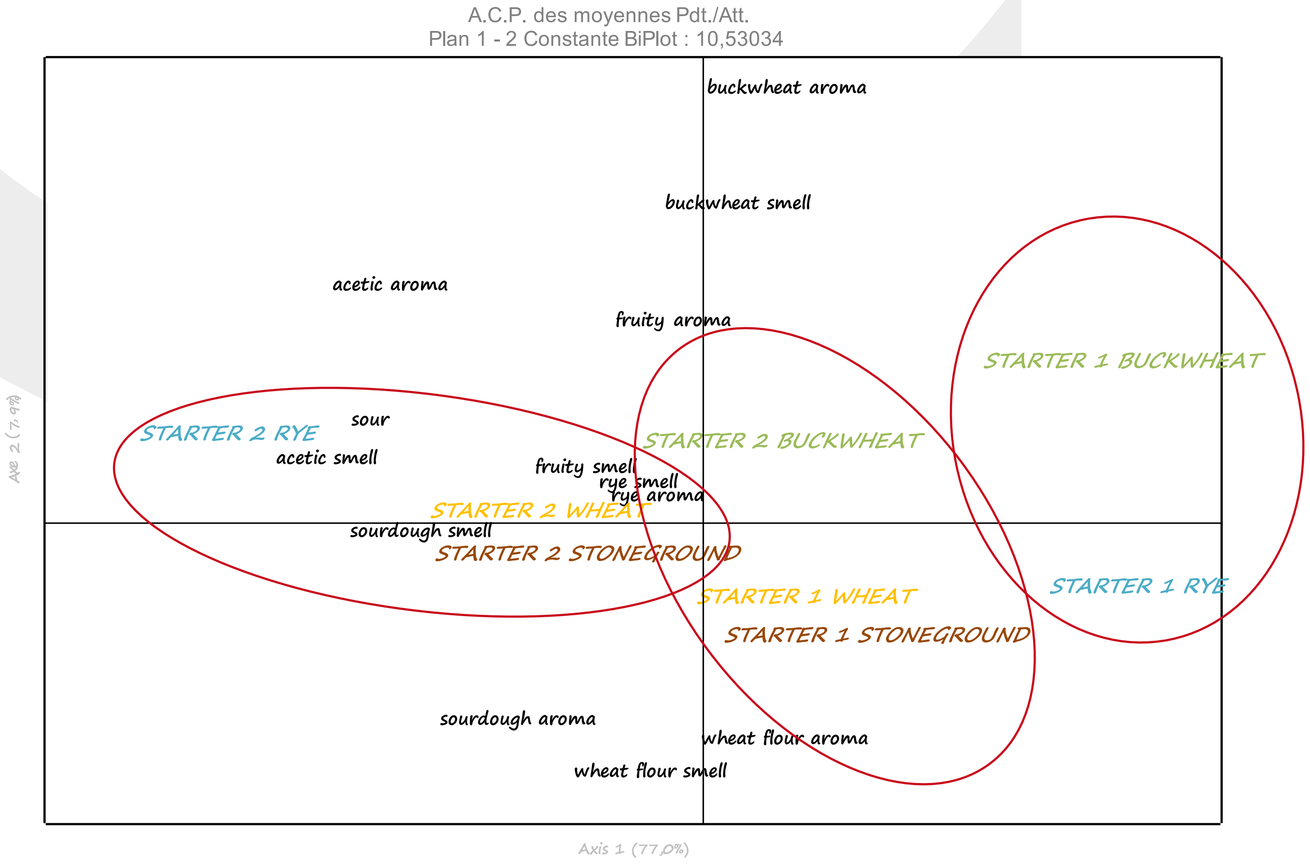
		Rye	Wheat	Stoneground	Buckwheat
Starter 1	pH	5.7	4.5	4.7	5.8
	TTA (mL)	2	6.2	5.6	2.2
Starter 2	pH	4.5	4.6	4.4	4.5
	TTA (mL)	7.8	5.8	7.5	7.9

With **Starter 1**, big differences are noticed depending on the type flour used. Rye and buckwheat flour sourdoughs give bread with higher pH and low TTA (around 2mL). Higher acidity level is reached using wheat or stoneground flour.

With **Starter 2**, fermentation on rye, stoneground and buckwheat flour are perceived quite similar in terms of instrumental data with pH around 4,5 and TTA up to 7mL.

Bacteria type and ratio seem to have little impact on wheat flour fermentation whereas it is strong on rye and buckwheat (+ 5mL TTA).

Sensory results

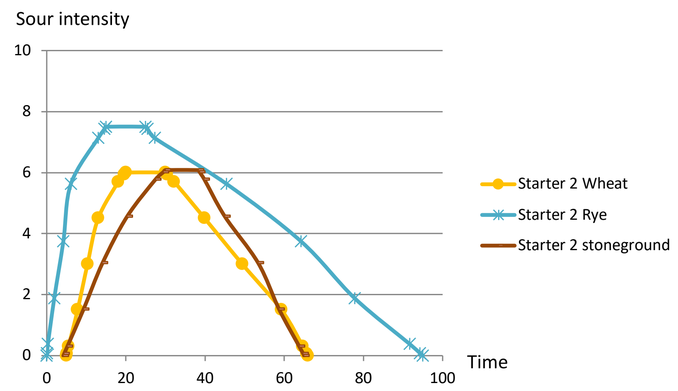


3 groups of breads are identified showing that depending on the flour used, the sourdough fermentation leads to different aromatic profiles. Y axis is strongly linked to sourness, acetic and sourdough flavours and discriminate the 3 groups.

Bread with Starter 2 on rye, wheat and stoneground flour compose a group characterised by strong sourness, acetic and sourdough flavours. Starter 1 on buckwheat and rye flour are at the opposite of the map because they are not very sour and have slight acetic & sourdough flavours. The intermediate group, with intermediate sourness is compose of Starter 1 on wheat flour, Starter 1 on stoneground flour and Starter 2 on buckwheat flour.

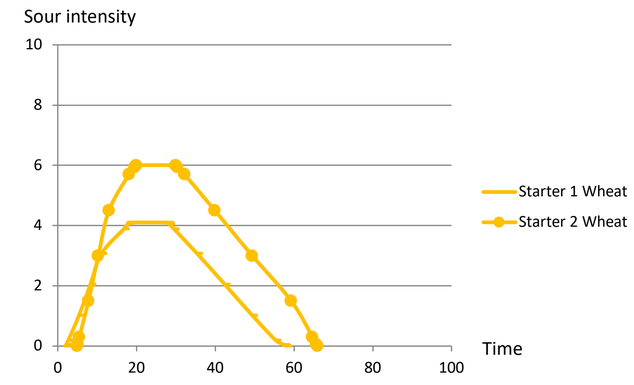
A strong impact of Starter 2 on rye flour vs Starter 1 has to be noticed. The aroma profile is greatly modified.

Impact of Starter 2 on different flours



When a focus is made on evolution of sourness perception in the time, it is interesting to see that there are big differences in the most acid group. With rye flour, the acidity is perceived slightly stronger and lasts longer in mouth (+40%).

Impact of Starter 1 and 2 on wheat flour



For the case of wheat flour, instrumental data did not show differences depending on the Starter used. Sensory methods showed the impact : +2 in intensity at T_{max} and 10% more longer in mouth.

CONCLUSION

This study allows to conclude on the most interesting associations between flours, yeast and bacterias to obtain a desired acidity. Fermentation with **Starter 1** which mixes homofermentative *L.plantarum* and heterofermentative *L.brevis* with yeast, reaches more sourness with wheat & stoneground flour vs rye and buckwheat flour (confirmed by analytical & sensory results). Fermentation with **Starter 2** comprised of the heterofermentative *L.brevis* and yeast is well adapted to rye flour giving high sourness. Bakers can offer a large aromatic range to final consumers, obtaining different typicity thanks to combining fermentation various flours and yeast/bacterias in fermentation.

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A new way to develop sourdough breads: analyze **dynamically** the *consumers' appreciations*

by Marine Baudin, Camille Dupuy, Caroline Vandermersch - Lesaffre International

CONTEXT

Considered as the best source of various and strong aromas, sourdough breads have been more and more developed by bakers since the 2000's. Moreover, these breads contain different types of acids which are correlated to chewing kinetics. Indeed, the acidity could enhance flavors or modify aftertaste in mouth. That is why it is interesting to develop a method to describe dynamically these breads and to relate this information to consumer appreciation.

MATERIALS & METHODS

1

Panelists: 16 smell and taste expert panelists

Products: 10 breads' profiles done > 3 significantly different breads identified for this study (1 control and 2 sourdough breads S1 and S2)

Sensory method: TDS (Temporal Dominance of Sensations) – Measures the dominant attributes of a product throughout a tasting period. The panelists have been previously trained on the attributes* assessed. (*Refer to "Le Pain in words" for more details (1))

Attributes: sourdough, fruity, wheaty, rye, smoky, acidic, "I swallowed"

PROTOCOL

1. Place the sample in the mouth and select the 1st most dominant attribute felt in the list.
2. Select an attribute each time a new dominant sensation appears.
3. After swallowing, indicate "I swallowed" and wait until the end of the chronometer (50 seconds (sec)).

2

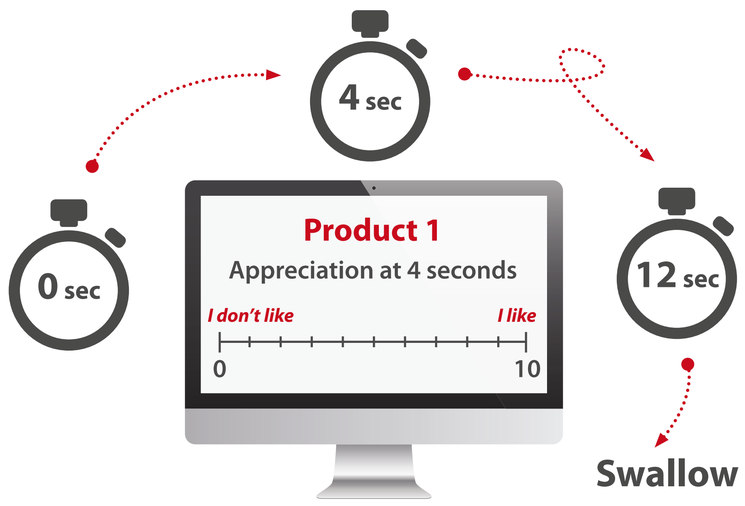
Panelists: 44 initiated or naive panelists

Products: the same 3 selected breads

Sensory method: Progressive liking – Dynamic and descriptive measure of the appreciation intensity at specific times (4 sec, 12 sec and after swallowing).
These times were determined thanks a thesis in sensory analysis (2) and from the most significant data obtained with the TDS method.

PROTOCOL

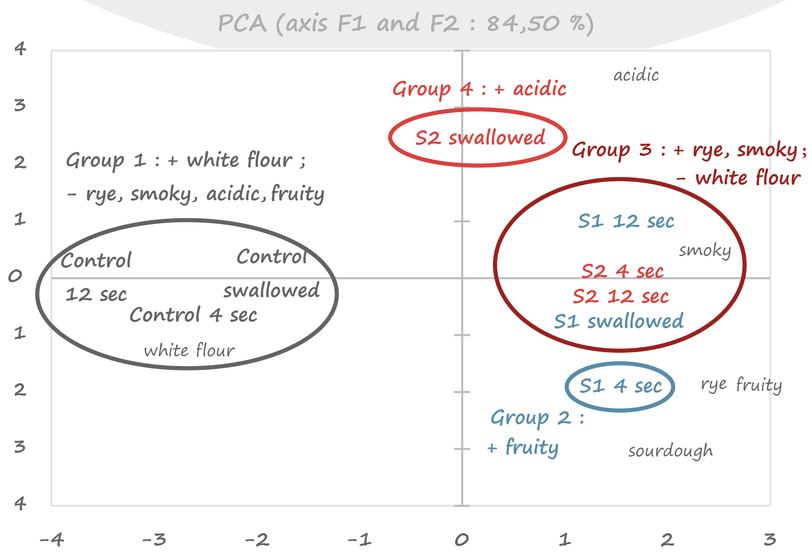
1. Put the sample in the mouth
2. Chew it during 4 sec and spit it.
3. Assess your product's appreciation on a scale.
4. Repeat the procedure twice (12 sec and after swallowing).



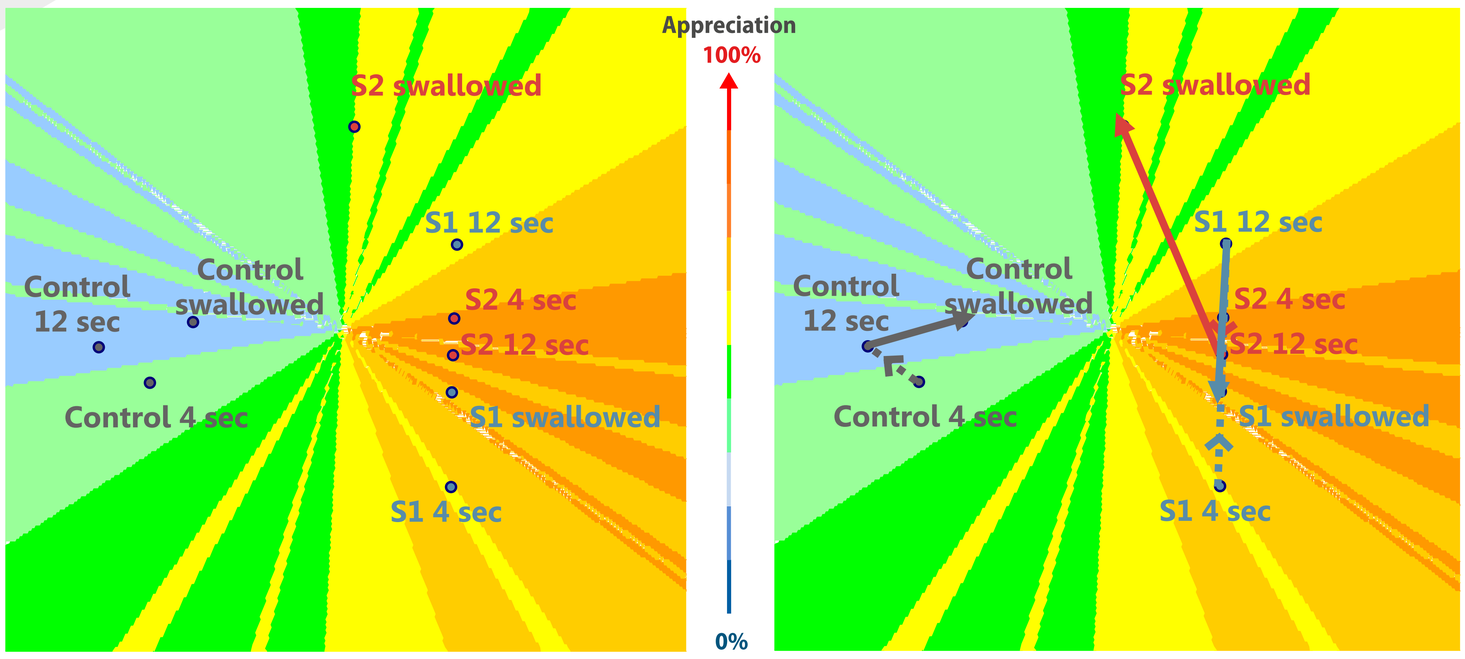
3 **Statistical analysis:** Combination of **both results** using an **Agglomerative Hierarchical Clustering (AHC)**, a **Principal Component Analysis (PCA)** with 9 products (3 different products at 3 different times) and a **preference mapping (PREFMAP)** with the software XLSTAT.

RESULTS

PCA



PREFMAP



PCA: 4 groups have been identified from AHC. There is more evolution during the 1st part of the chewing for product S1 than for product S2. This could be the result of the acidic notes appearing later, due to the flavor releasing process linked to the action of saliva and bread structure.

PREFMAP: Consumers seem to prefer products with rye, smoky and fruity notes (group 3) whereas they dislike white flour notes (group 1). Product S2 is the most liked during tasting. However its appreciation declines significantly once it is swallowed. At this moment, the acidic taste has been totally released. In contrast, product S1 is preferred once swallowed than during tasting. Consumers may prefer breads with a wide and complex flavor than an isolated note.

CONCLUSION

The combination of both methods could be a new tool for the development of sourdough based products, bringing dynamical information on the consumers' appreciation. Its perception evolves throughout the tasting, and differently depending on the product.

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Using **sourdough to achieve significant salt reduction** in bread

by Pauline Semeria, Marine Baudin, Claire Micheaux - Lesaffre International

CONTEXT

Salt content is one of the major health issues today. Consumer awareness is growing and the market sees numerous launches of foods displaying « low salt » claims. Nevertheless intake in Europe is still too high . The challenge is set as salt plays a major role in the taste of products as well as on the process and bread structure. In this work we developed a product allowing a significant reduction in bread salt content, without decreasing its organoleptic properties so that it may be fully adopted by consumers in their diet.

MATERIALS & METHODS

Step 1.

Study existing functional ingredients for salt reduction and their impact on the organoleptic characteristics of wheat breads, direct baking process:

1. **NaCl reduction:** salt content of 1.8% and 0.45% on flour basis were compared by 15 expert panelists in appropriate sensory laboratory conditions, with QDA method. Statistical analysis made using student t-test with a 5% threshold
2. **Substitution by KCl:** 2 ratios of KCl levels were tested against a control bread at 1.8% NaCl ofw. Breads were evaluated by 15 expert panelists in appropriate sensory laboratory conditions, with QDA method. Statistical analysis made using ANOVA (Analysis of Varaiance) and an average comparison test (Newmans Keuls at a 5% of risk).
3. **Addition of sourdough:** sourdough was prepared with Lesaffre LV2 starter on wheat flour (fermented 24h at 28°C) and added at 30% to the dough of a salt reduced recipe containing 1.6%NaCl ofw. It was compared to a control bread at 1.8% NaCl and one a reduced salt content without sourdough. Salt perception was tested by 15 expert panelists thank to a ranking test and statistical analysis made using a Friedman test 5%.

Step 2.

Combine knowledge in fermentation and formulation to generate a novel sourdough based solution for efficient salt reduction.

- **New product testing:** Sourdough based preparation « SR40 » containing white rye sourdough and KCl was tested in baking at 5% ofw and compared to control breads at 1.8% and 1.4% salt. Salt intensity profile during tasting was evaluated by 18 expert panelists using the DTS method.

Step 3.

Validating in different applications using triangle tests with initiated people. Breads tested contained 1.8% salt or 40% salt reduction replaced by 5% SR40.

1. Triangle test made by 23 initiated panelists comparing effect in classic industrial applications: tin bread, croissant and buns, statistical analysis binomial test (probability 1/3) was used.

RESULTS

Step 1.

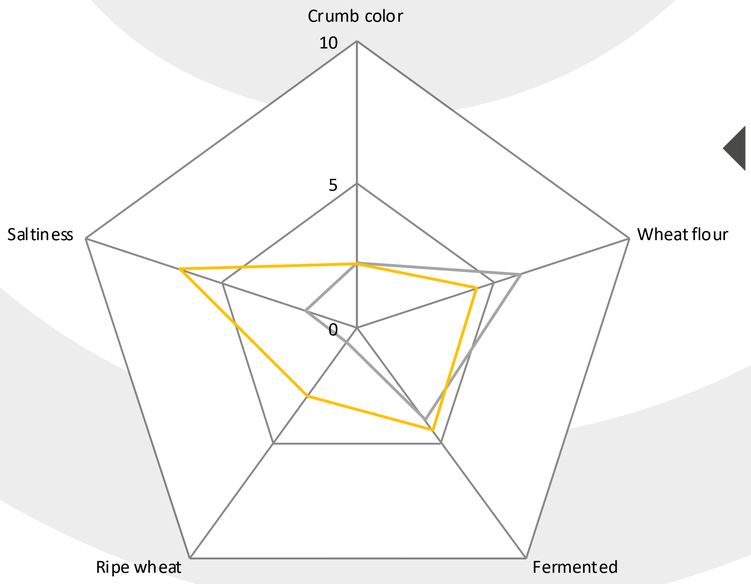

Fig. 1. When reducing salt level in white bread, salt taste is significantly decreased and so are other flavours such as ripe wheat flavour. Those are generally appreciated by consumers and unsalted breads show poor acceptability by the market.

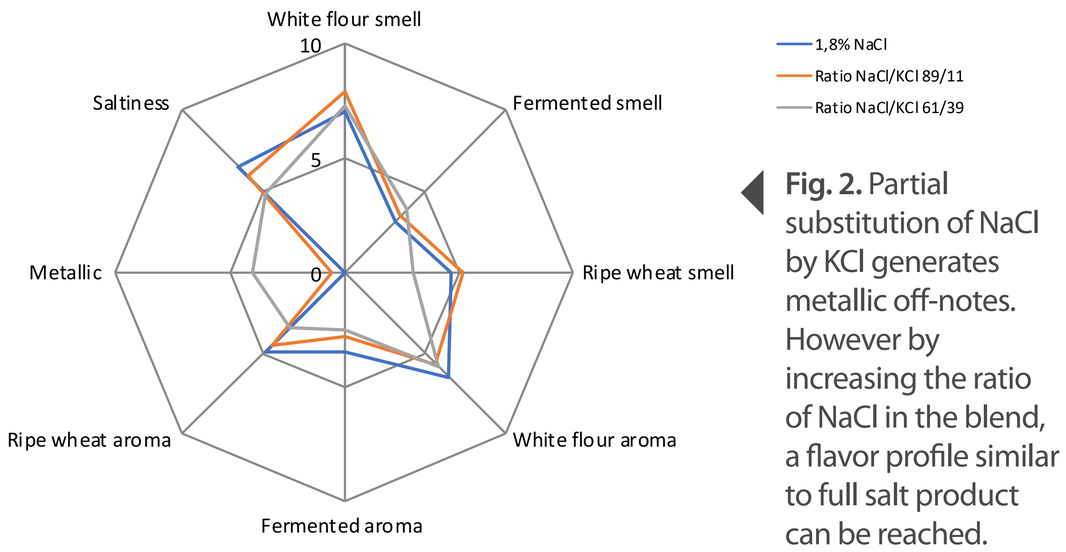

Fig. 2. Partial substitution of NaCl by KCl generates metallic off-notes. However by increasing the ratio of NaCl in the blend, a flavor profile similar to full salt product can be reached.

Fig. 3. The impact of sourdough to enhance salt perception in the crumb is confirmed. The addition of 30% sourdough can correct a decrease of 10% salt in the recipe for an initial dosage of 1.8%.

Step 2.

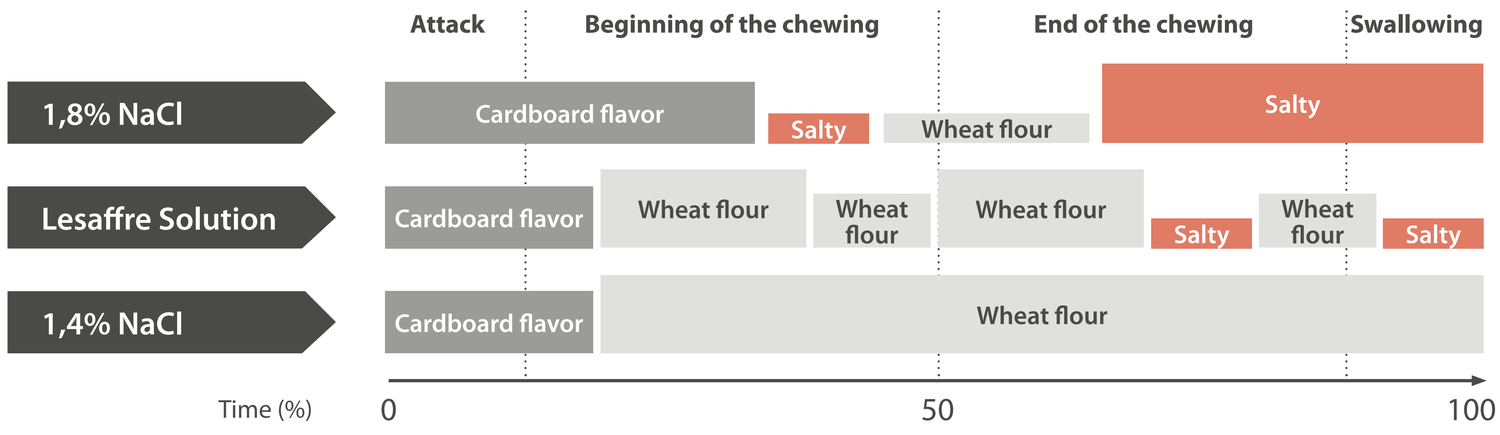

Fig. 4. 1.4% NaCl content gives a bread with dominant cheat flour note, and salt perception is never dominant. With the SR40 product, the dynamic taste profile is closer to the control bread at 1.8% NaCl, showing alternating salt dominance at the end of the chewing.

Step 3.

1,8% NaCl vs 1,4% NaCl + SR40

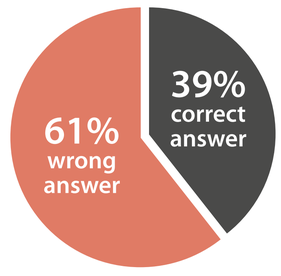

Fig. 5. The triangle test shows there is no significant difference in the products tested

CONCLUSION

The work carried out led to the development of a novel solution for salt reduction combining a specific liquid sourdough and mineral salt to efficiently reach 40% salt reduction in various bakery applications. Rheological properties of fresh breads are similar to that of a fully salted dough. Sourdough being known for improving crumb freshness, SR40 solution could generate an advantage to the baker and consumer increasing shelflife of reduced salt products. Further testing dedicated to texture analysis would be of interest here.

REFERENCES: Quilez and Salas-Salvado. Salt in bread in Europe : potential benefits of reduction. Nutrition reviews. 2012;70:666-678
Sinopoli and Lawless. Taste properties of potassium chloride alone and in mixtures with sodium chloride using a CATA method. J Food Sci. 2012;77:319-322
Silow, Axel, Zannini, Arendt. Current status of salt reduction in bread and bakery products - A review. J. Cereal Sci. 2016;72:135–145
Lesaffre Technical Library – Salt reduction in baked goods

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Development of a **predictive model on acidity and gasing power** in liquid sourdough **according to recipe & process parameters**

by Florence Delchambre, Rémi Poisot, Anas Malki, Simon Carrière, Emilie Bryckaert - Lesaffre International

CONTEXT

The sourdough is a mixture obtained by a symbiotic culture of lactic bacterias and yeasts that develops in a media made of flour and water. A wide diversity of sourdough can be observed according to the micro-organisms that inoculate the sourdough. But the maturation process parameters also enable us to reach as well such a diversity of sourdoughs. For this study, we worked using a constant and controlled microbiota in order to study the impact of recipe and process on acidity of liquid sourdoughs. More precisely, the impact of cereal (ash content), coupled with time/temperature of maturation and hydration rate of sourdoughs were studied. The sourdough were produced with freeze-dried starters and matured for 24 hours. The Experiment plan methodology and more precisely a response surface was chosen to drive this study. This enables to develop a predictive model on liquid sourdough acidity and gasing power according to recipe and process parameters. This methodology was applied for the different measured indicators: acidity level in the sourdough (pH, TTA, Sg, acid concentrations), type of acidity in the sourdough (Fermentation quotient) and rising power of the sourdough in a lean dough (gas production and ethanol concentration).

MATERIALS & METHODS

1. Sourdoughs recipe & process

- The sourdoughs were made in double jacketed tanks – filled with 1,7 kg of liquid sourdough
- For recipe & process, refer to Table N°1

2. Experiment plan design

- Two types of design were used for this study :
  - Central Composite Face design composed of a full factorial design and star points placed on the faces of the sides (α = 1)
  - Central Composite Circumscribed design composed of a full factorial design and star points (α = 1,682)
- Modde Pro 12 Software was used to draw response surfaces

3. Acids & ethanol dosages

- HPLC was used to quantify lactic acid, acetic acid and ethanol in sourdoughs.
- Total titrable acidity (TTA) was measured on 10g of sourdough by titrating the acids with 0,1N NaOH until reaching pH=6,6

4. Gasing power measurements

- Doughs were prepared including 20% of each liquid sourdoughs, 2% of salt and 60% of water at 16°C (quantity of water of dough + sourdough - percentage calculated on flour weight).
- Volumes of CO_2 production were measured with a risograph equipment on a 50g dough during 3 hours at a proofing temperature of 30°C.

Table 1. Sourdoughs recipe & process parameters settings

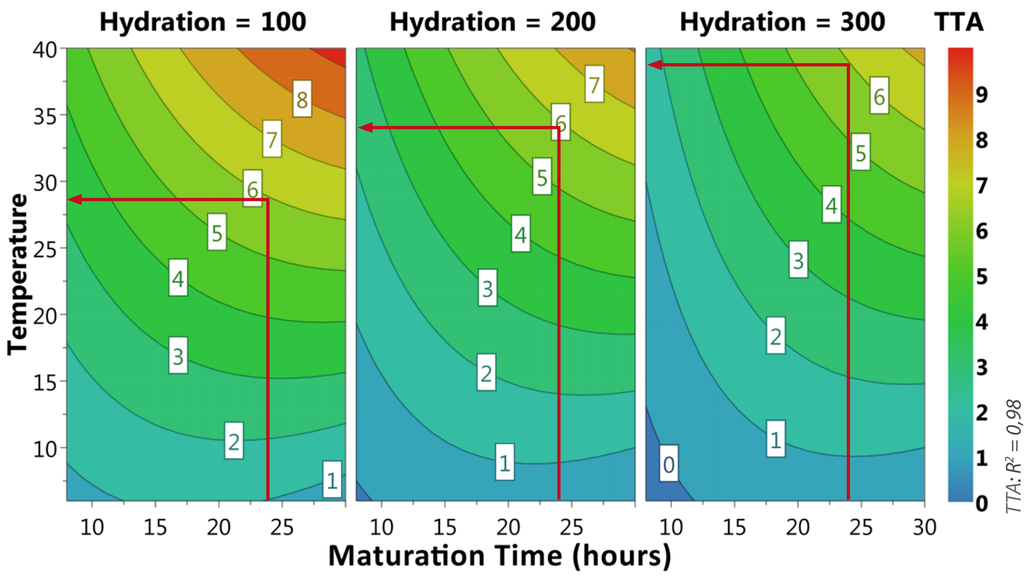
Recipe & process parameters	Level
Flour	Wheat T55 or T110
3 starters	Livendo LV1, LV2, LV4
Starter rehydration T°	30°C
Starter inoculation rate*	0,5%
Sourdough hydration rate*	100% to 300%
Salt content*	2%
Mixing speed and cycle	3' at 50 rpm every 30'
Maturation T°	6 to 40°C
Maturation time	8 to 30 hours

(*) Percentages calculated on flour weight

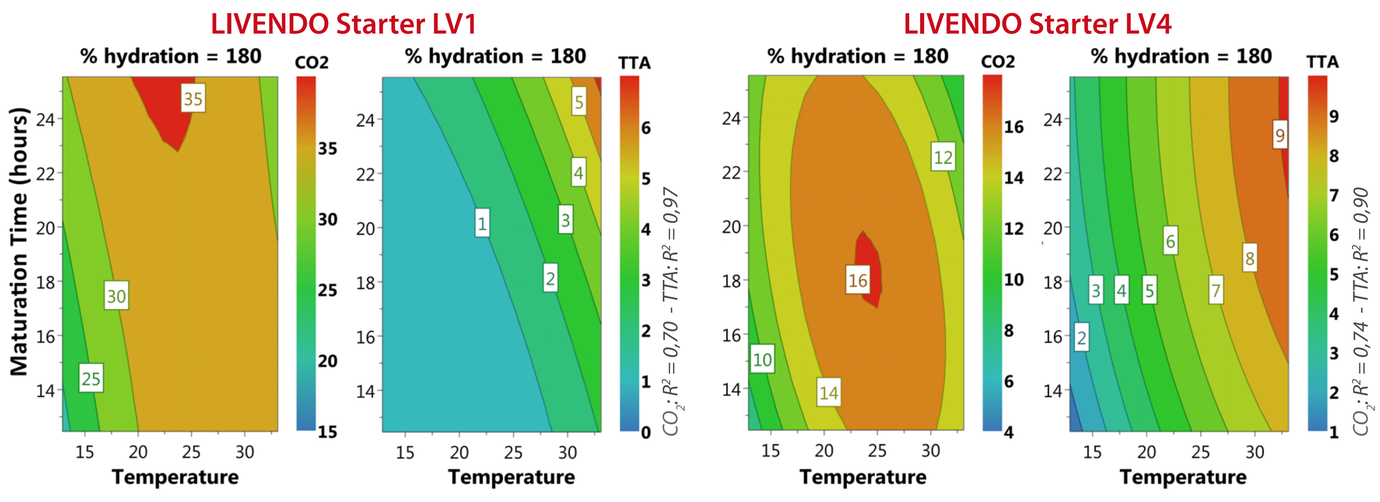
RESULTS

For each of the three starters, on both wheat flours, we have gathered many response surfaces. Here is an extraction of only a few surfaces to illustrate some process and recipe effects on the different acidity and fermentative indicators. It aims to give some examples on how to use the developed predictive mode which will meet the baker's demands.

Graph 1. Response surfaces for sourdoughs made with starter LV4 on wheat T55 flour : predictions on TTA indicator



Graph 2. Response surfaces for sourdoughs (hydratation = 270%) made with starters LV1 and LV4 on wheat T110 flour : predictions on sourdough TTA and CO_2 production in a lean dough after 3 hours of proofing at 30°C



Example 1

Datas & target

- The baker use a T55 wheat flour.
- Acidity target of the baker : type of acidity should be rather acetic & intensity should be medium (TTA ~ 6).
- Constraints = the maturation time should last about 24 hours to be more convenient for the baker's process planning.

Lesaffre solutions

- With a first prediction on fermentation quotient, we have selected the starter LIVENDO LV4 as it gives the more acetic profile.
- With a second prediction on TTA (Graph 1), Lesaffre can advise to the baker to mature its sourdough at a temperature of about 28°C with a hydration around 100%. If the baker prefers to work with a more liquid sourdough, we can propose him to increase his maturation temperature to still maintain is maturation time of 24h with the same acidity level target. For example, with a hydration of 200%, maturation temperature should be around 35°C.

Example 2

Datas & target

- The baker use a T110 wheat flour and has a hydration level of 180% for his liquid sourdough.
- He wants a sourdough that will bring a good leavening power to his lean dough bread.

Lesaffre solutions

- Depending on the starter and its composition (ratio yeast-bacteria and bacteria strain), different level of CO_2 production are obtained.
- With the prediction on sourdough's CO_2 production in a lean dough (Graph 2), Lesaffre can advise to use rather starter LIVENDO LV1.
- Sourdoughs that have been matured at an intermediate temperature of 20-25°C seem to give the highest CO_2 production in the lean dough after 3 hours of proofing.

CONCLUSION

More than 200 sourdoughs were made to gather enough data to build this predictive model. In total, for each of the 8 studied indicators (pH, TTA, Sg, lactic and acetic acids and ethanol concentrations, fermentative quotient, CO_2 production), 6 prediction equations were written for the 3 starters with the 2 ash content wheat flours. Predictions on these 8 parameters were thus obtained on a wide experimental field and are a simple and efficient advising tool. Indeed, it helps the baker to choose the right starter to reach the targeted type of acidity (acetic or lactic). Moreover, it helps him to identify the adapted process & recipe parameters to reach his precise targeted acidity intensity. At least, the choice of the starter can be done as well regarding the gasing power of the sourdough according to the type of bread recipe used by the baker.

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Study on scalded hydrolyzed flour and its impact on the lag phase of sourdough inoculated with freeze-dried micro-organisms

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CONTEXT

Freeze-dried starters are good tools for bakers to develop a constant quality sourdough after only 18 to 24 hours of maturation. Nevertheless, these starters often display a long lag phase of about 6 to 8 hours. In a general way, the composition of maturation media is a critical parameter for the development of micro-organisms that can stimulate or, on the contrary, inhibit their activity. Moreover, the boiling process of flours, is traditionally used in breadmaking in Central and Eastern Europe for several reasons: stimulation of yeast or bacteria activity in fermented doughs, increasing of dough hydration for better yields and optimization of shelf life (softness and moisture). This method, when coupled to a hydrolysis step, enables to generate simple sugars or other nutrients in the maturation media. For this study, we have produced sourdoughs inoculated with freeze-dried starters on hydrolyzed scalded flours. Several parameters of the boiling and hydrolysis process were studied (ex. enzymes dosage, type of enzymes) in order to elaborate different media in terms of nutrients composition. The aim was to study the impact of these media composition on the reduction of lag phase of freeze-dried starters in sourdough.

MATERIALS & METHODS

1. Sourdoughs maturation

- 6 sourdoughs were made :
  - Sourdough on rye flour
  - Sourdough on scalded rye flour
  - Sourdough on scalded rye flour + ENZ A
  - Sourdough on scalded rye flour + ENZ B
  - Sourdough on scalded rye flour + ENZ C
  - Sourdough on scalded rye flour + ENZ A + ENZ B + ENZ C
- Sourdoughs were maturated for 24 hours at 35°C

2. Glucose & acids dosages

- HPLC was used to quantify lactic and acetic acids in each of these 6 sourdoughs
- Total titrable acidity (TTA) was measured on 10g of sourdough by titrating the acids with 0,1N NaOH until reaching pH=6,6

3. Evaluation of bread taste & smell

- Experts panel of 10 persons worked on the profile of each bread using the QDA method. The statistical analysis lies on a variance analyses.

Table 1. Sourdoughs recipes

SOURDOUGH	COMPOSITION
Sourdough on rye flour	900g rye flour T170 + 585g water 30°C
Sourdough on scalded rye flour	450g rye flour T170 + 900g water 98°C

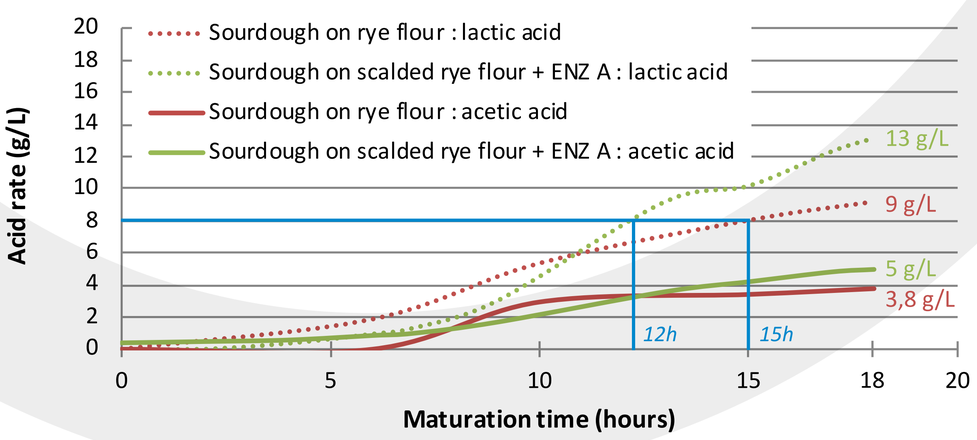
Table 2. Starters & enzymes dosages

INOCULATION & ENZYMES	COMPOSITION
Starter LIVENDO LV4 (*L. brevis – S. chevalieri*)	0,5%*
ENZ A (*α-amylase + amyloglucosidase*)	6% (alone) or 1% (in mixture with other enzymes)*
ENZ B (*protease*)	0,01%*
ENZ C (*arabinofuranosidase*)	0,05%*

(*) Percentages calculated on flour weight – Enzymes on carrier

RESULTS

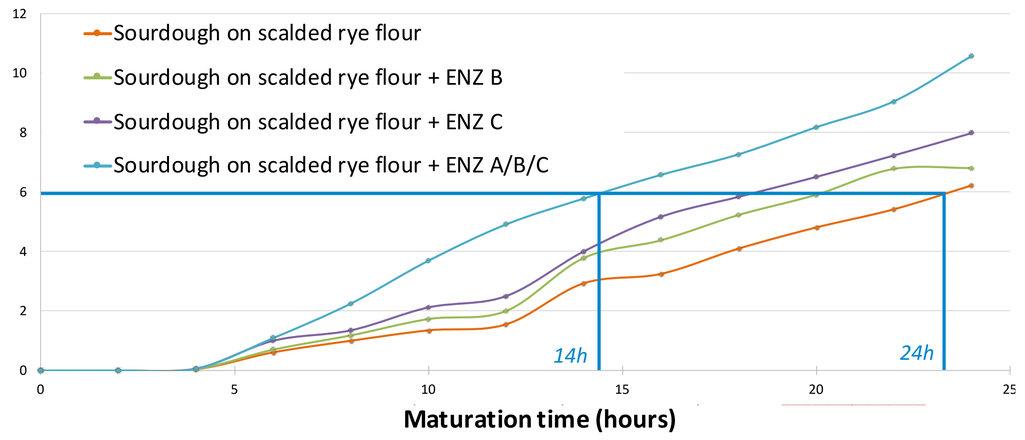
Graph 1. Impact of scalding and saccharification of rye flour on sourdough acidity



The trials made on rye flour + ENZ A and scalded flour without ENZ A are not showed as they are close to reference (sourdough on rye flour).

- The lag phase (around 6 to 8 hours) of bacteria does not change with the presence of the saccharified scalded flour compared to a maturation on a conventional rye flour. The glucose assimilation **boosts the production of acids**. Thus, after 18 hours of maturation, 13g/L of lactic acid is produced by the bacteria on a saccharified scalded flour compared to 9g/L on a non scalded flour. The trend is the same for acetic acid (5g/L of on a saccharified scalded flour compared to 3,8g/L on a non scalded flour).
- If the target of lactic acid content is around 8g/L, the maturation time would be 12 hours on a saccharified scalded flour compared to 15 hours on a non scalded rye flour.

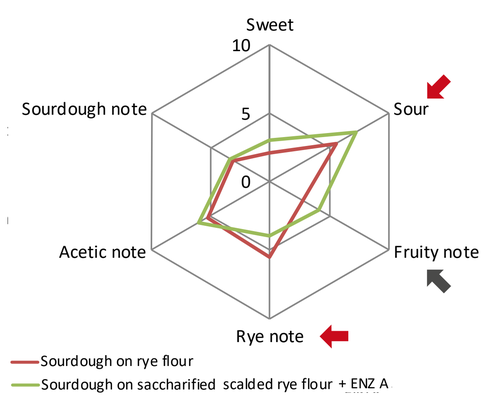
Graph 2. Impact of scalding and hydrolyzing of rye flour on sourdough acidity



- The lag phase (around 6 hours) of bacteria does not change with the presence of hydrolyzed scalded flour with different enzymes. However, we can boost the bacteria acids production thanks to the generation of different nutrients in the sourdough all along the maturation time. As an example, the sourdough matured on a hydrolyzed rye flour with 4 enzymes (A, B, and C) displays a TTA nearly two times higher (TTA 24h = 10,6) than the TTA observed on a scalded rye flour – not hydrolyzed (TTA 24h = 6,2).
- As an example, if the acidity target (TTA) is around 6, the maturation time would be around 14 hours on a hydrolyzed scalded flour compared to 24 hours on a non hydrolyzed scalded rye flour.

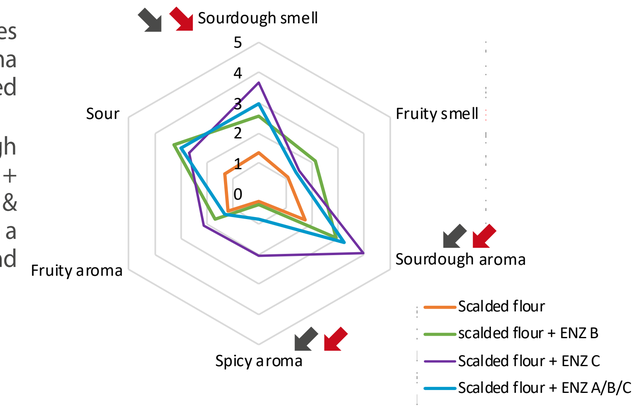
Graph 3. Impact of scalded and saccharified sourdough on a rye bread profile

- The boosting effect of the starter maturation on a saccharified scalded flour on the acids production demonstrated above has a significant impact on the taste of the bread (green curve). Indeed, the sour savor is significantly higher for this bread than for the one including a sourdough maturated on a conventional rye flour (red curve). Moreover, the rye notes are less intense for the bread made with sourdough on saccharified scalded flour. A trend shows that the fruity note is slightly higher giving a richer aromatic profile.



Graph 4. Impact of scalded and hydrolyzed sourdough on a wheat bread profile

- Expert panel has detected significant differences on sourdough smell & aroma and on spicy aroma for the bread made with sourdough on scalded rye + ENZ C compared to the 3 other breads.
- Someothertrendsare:breadsmadewithsourdough on scalded flours + ENZ B or on a scalded flour + ENZ A/B/C are intermediates ("sourdough" & "spicy") between the reference bread made with a sourdough on a non hydrolyzed scalded flour and bread with ENZ C.



Significant difference (5%)

Trend (10%)

CONCLUSION

- The maturation of sourdough with scalded hydrolyzed rye flour boosts the bacterias' acids production during the 24 hours of maturation.
- This method thus enables a stimulation of the exponential phase of the bacterias metabolism. On the contrary, the lag phase remains unchanged. But such stimulation of the exponential phase enables to reach higher acidic sourdoughs or to shorter significantly maturation times.
- Moreover, the use of saccharified/hydrolyzed scalded rye flour for sourdough maturation in breads enables a personalization of the aromatic profile of these breads.
- Declination of this method on different flours, such as wheat or gluten free flours, can be a good way to bring higher acidity to bread with a profile of nice complex aromas.

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