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

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Deliverable D6.2

Report on the industrial implementation of the reformulated meat products and recommendations

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Contributors: ADIV, BOADAS

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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1. Summary

In the previous task 2.1, it was made a screening of the recipes and technologies available to reach a 60% saturated fatty acid reduction and a 30% sodium reduction in French dry sausages. For the cooked sausages, the goal was a 50% reduction in both fat and sodium content. In the tasks 2.4 and 2.5, ADIV and BOADAS have optimized two Spanish dry sausages: the chorizo extra and the snack fuet extra, while Leiv Vidar and Nofima in collaboration have optimized the recipe and process for frankfurters.

ADIV demonstrated at pilot scale that the use of fat emulsion and fibers was a good solution to reach the SFA reduction. For salt reduction, the cold predrying during 3 days associated with a 30% substitution of NaCl by KCl or addition of yeast extract associated with 40% salt substitution by KCl were efficient technologies.

Then, Boadas demonstrated at pilot plant that binary reduction in SFA and sodium can be achieved simultaneously.

For snacks of fuet the better tests in terms of texture and taste are with oil and fiber addition + modified KCl + flavor 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 by ADIV and Boadas and finally for expert judges and consumers) shows that new formulations are very close to the control and there aren't significant global differences with it.

TeRiFiQ objectives of binary salt and saturated fat reduction in dry sausages have been successfully achieved. BOADAS Company can now market Chorizo extra and Snack fuet extra with the claim "product reduced in salt and saturated fat" according to European regulation.

For the cooked sausages it was found that potassium could be a good substitute for sodium, and it is possible to exchange 20-30% of the sodium without influencing the sensory properties. Total fat content can be decreased, but a 50% reduction could be difficult without influencing texture and flavour.

2. Approach

2.1 Subtask 6.2.1

2.1.1 Industrial production of cooked sausages

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. 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 and fat were the two factors only which were tested in full-scale production.

2.2 Subtask 6.2.2

2.2.1 Industrial production of dry fermented sausages

The main objective of the task is:

- To transfer and demonstrate at industrial scale the applicability of the technologies developed from WP2 in Boadas industrial production process.

The development at industrial scale has been made, as accorded, only with snacks of fuet because the manufacturing technology is very similar to the chorizo one.

It was selected the best reformulated test using the following criteria:

- tested in pilot plant at lab scale in WP2 to ensure industrial feasibility

- accepted at consumer level

- tested and controlled in terms of nutritional quality and safety

- acceptability regarding cost benefit analysis for each studied product

Taking into account all these facts, the best test is P12: best test accepted at consumer level, best test in terms of nutritional quality and safety and best test regarding cost benefit analysis.

TEST P12	**FAT REDUCTION: sunflower oil with wheat fiber + lean meat**
	SALT REDUCTION: 40% salt substitution by modified KCl + yeast extract M

3. Industrial scale production of cooked sausages

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, see Table 1. In addition, some of the sodium was replaced with potassium and three recipes had less fat than the reference.

1)	18% fat	2.2% NaCl	(reference sausage)
2)	18% fat	1.4% NaCl + 0.4% KCl	
3)	18% fat	1.2% NaCl + 0.6% KCl	
4)	14% fat	1.8% NaCl	
5)	14% fat	1.4% NaCl + 0.4% KCl	
6)	14% fat	1.2% NaCl + 0.6% KCl	

Table 1. Fat and salt content in sausages selected for sensory evaluation.

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.

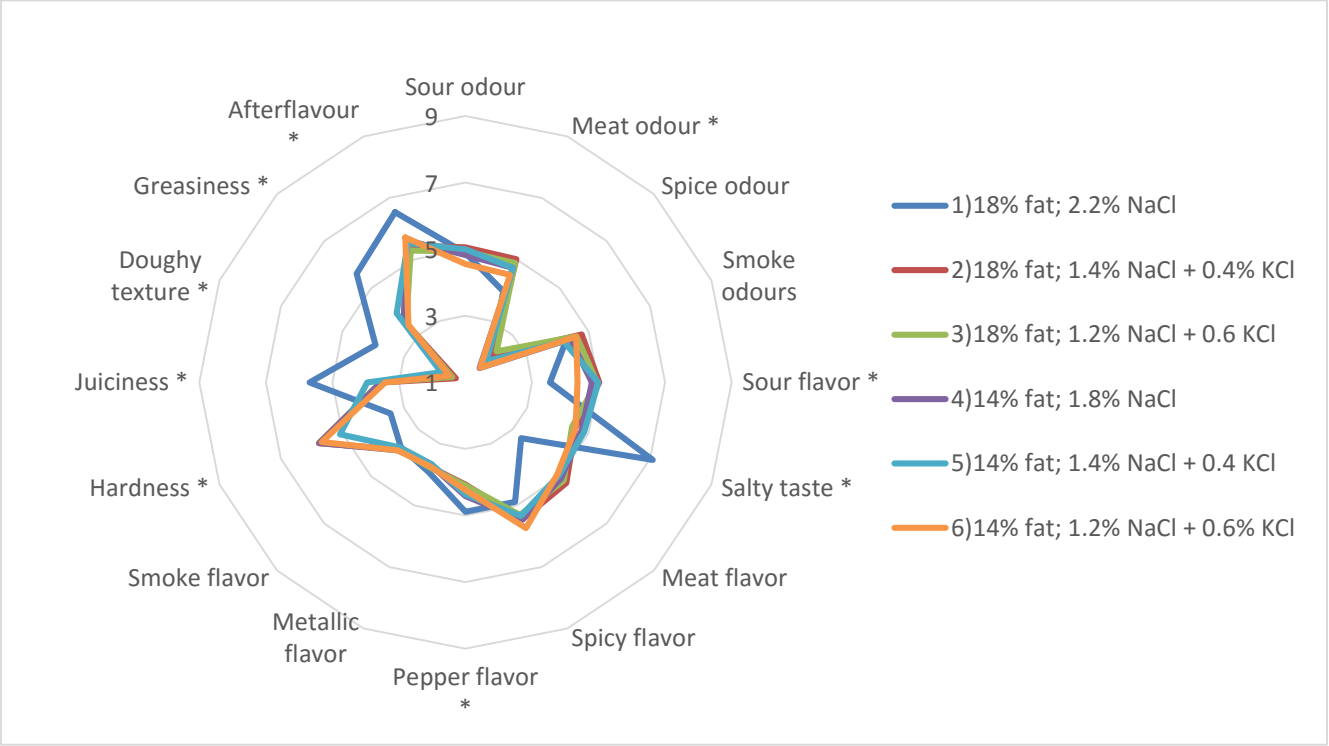


Figure 1. Spider web diagram of sensory attributes for sausages.

4. Industrial scale production of dry cured sausages

4.1 Materials & methods

4.1.1 Industrial snacks of fuet test

An industrial test of 680 Kg approx. of cured snacks of fuet was elaborated. 250 Kg control (1 mixer) and 430 Kg test P12 (2 mixers) (Figure 2).

2 identical mixers of test P12 were done due to the high variability of the dry cured products (variability of meat, variability in drying process…). If both mixers do not present significant differences, could be concluded that results are quite reliable

All reduced industrial test results are an average of the 2 performed mixers.

Each mixer (control and reduced) contained the same rate of nitrite salt, colouring, ingredient mix and KNO_3.

Snacks of fuet process was managed to achieve a total weight loss between 45% and 50%.

Figure 2: Industrial scale production of reduced fat and salt snacks of fuet

4.1.2 Products analysis

For industrial snacks of fuet test, physical, chemical and nutritional analyses were done:

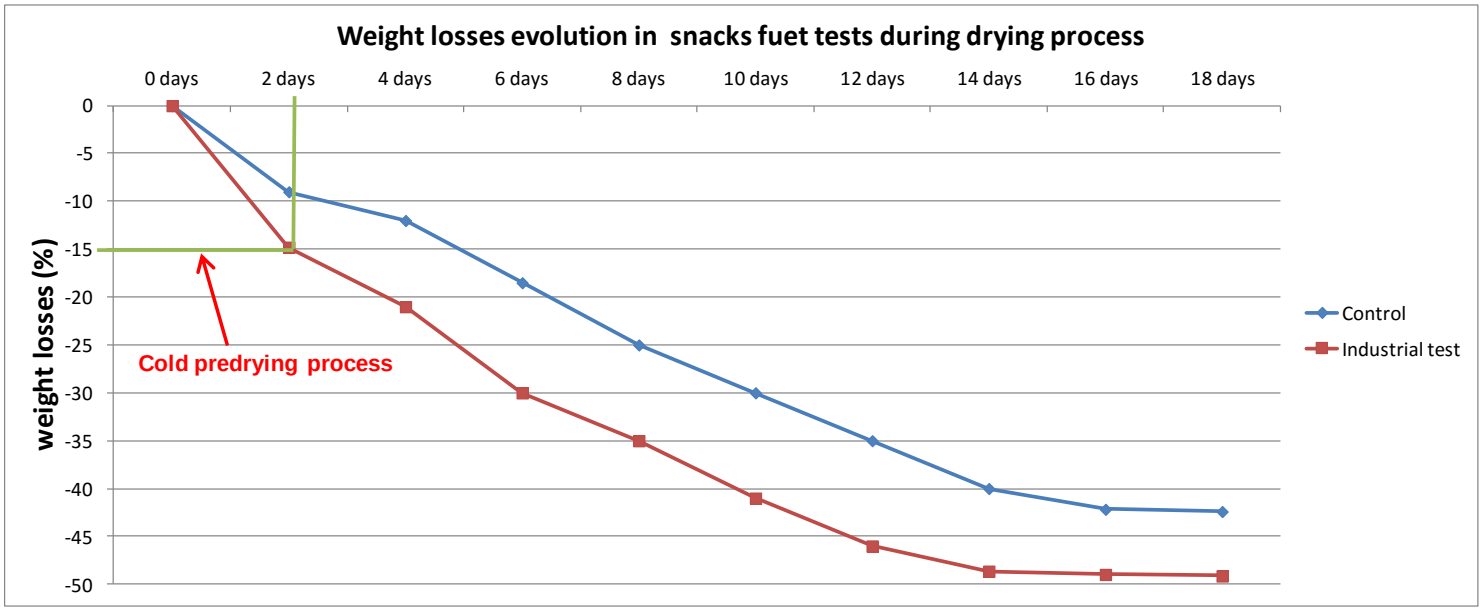
- Lipid (norm B.O.E. 29-08-1979) and humidity content (norm UNE 34552) on dry products: 1 measurement / trial
- Fatty acid profile (norm AOAC 963.22) to quantify saturated, monounsaturated and polyunsaturated fatty acids on dry products: 1 measurement / trial
- Sodium and NaCl content (norm AOAC 969.23, 990.23, 985.35) on dry products: 1 measurement / trial
- Weight loss measurement on 3 pieces per mixer at different days until end of drying. Weight loss at day "n" is calculated thanks to the formula: weight loss $_{(day\ n)}$ (%) = 100 x (weight $_{day\ n}$ (kg) –weight$_{day\ 0}$ (kg))/ weight$_{day\ 0}$ (kg)
- pH measurement on 5 pieces per mixer at different days at the core of the product with pH-meter Hanna© HI 99163,
- Visual aspect of dry sausages at the end of drying
- Informal sensorial evaluation of dry products by BOADAS team

4.2 Results of the industrial scale tests for snacks of fuet

4.2.1 Weight losses evolution

In reference to the weight losses of snacks of fuet (Figure 3), the results show quicker water losses for industrial test. This is due to the higher water content in test batters and the cold pre-drying process.

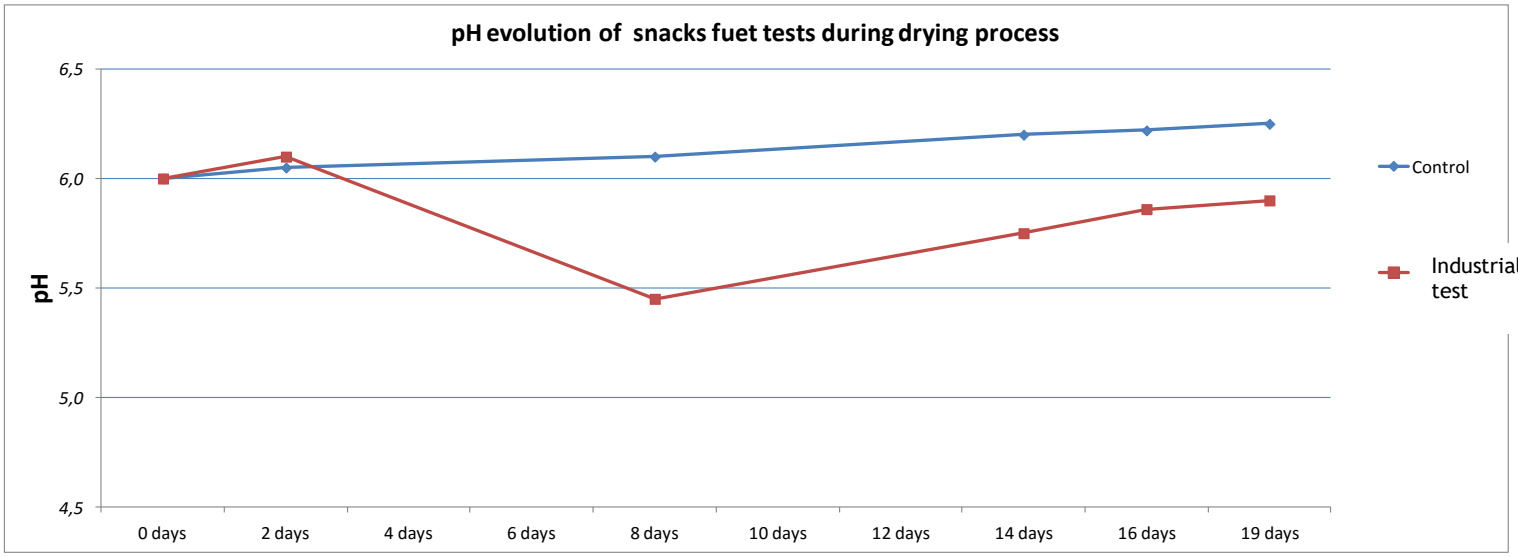
Figure 3: Weight losses evolution of snacks of fuet tests and control during drying process



4.2.2 pH evolution

The results of pH evolution for snacks of fuet industrial tests (Figure 4) demonstrate that with pre-dried process at low temperature the pH decreased a little bit. For that reason, efficient microbial results were obtained (ADIV conclusion in pilot scale tests).

Figure 4: pH evolution of industrial scale test for snacks of fuet during drying process



4.2.3 Chemical analysis

In the chemical analysis of snacks of fuet industrial test at the end of the drying process, it could be seen simultaneous reductions: more than 70% reduction in SFA and more than 35% reduction in sodium (Table 2).

Table 2: Chemical analysis results for snacks of fuet industrial test compared with average of market and target project

Test	Fat (%)	% reduction of fat	SFA (%)	% reduction of SFA	Salt (%)	% reduction of NaCl	Sodium (%)	% reduction of sodium
Industrial test	16,46	-62,84	5,23	-72,62	2,48	-35,42	0,99	-37,34
Average similar products from market	44,30		19,10		3,84		1,58	
Target for project	31,01		13,37		2,88		1,18	

4.2.4 Sensorial assessment

In sensorial evaluation, the industrial test had good sensory quality (Table 3). Characteristic taste of fuet was achieved.

Table 3: Sensorial assessment of snacks of fuet tests and control by ADIV and Boadas team

TEST	TEST DESCRIPTION	ADIV and BOADAS sensorial evaluation	OVERALL EVALUATION
Control	Boadas standard	Boadas standard	
Industrial test	TeRiFiQ recipe	Good aroma, taste and aspect, good texture	+++

5. Conclusions from industrial scale production

5.1 Cooked sausages

- ✓ 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
- ✓ Fat content can be decreased without significant change in sensory perception

5.2 Dry-fermented sausages

- ✓ The different reduced industrial test mixers didn't show significant differences, so it could be concluded that the results are quiet reliable
- ✓ More than 70% reduction in saturated fatty acids (SFA) and more than 35% in sodium could be achieved
- ✓ For snacks of fuet the best tests in terms of texture and taste are with sunflower oil with wheat fiber, modified KCl and flavor enhancer (yeast extract).
- ✓ Sensorial attributes are very close to control on every criteria. Characteristic taste of snacks of fuet is achieved
- ✓ With the pre-dried process at low temperature we have efficient microbial results because the pH is lower than control
- ✓ Yield of reduced test at industrial scale is a little bit lower than control (10%), however, it could be concluded that reduced products at industrial scale are affordable
- ✓ The implementation of research activities in WP2 and WP6 leads to the demonstration that new strategies are efficient to reduce simultaneously the salt and saturated fatty acid contents in dry sausages, respectively by 35% and 70 %. TeRiFiQ activity on dry sausages is successful and will give solutions to meat companies to offer healthier products for consumers and without losing the product authenticity.