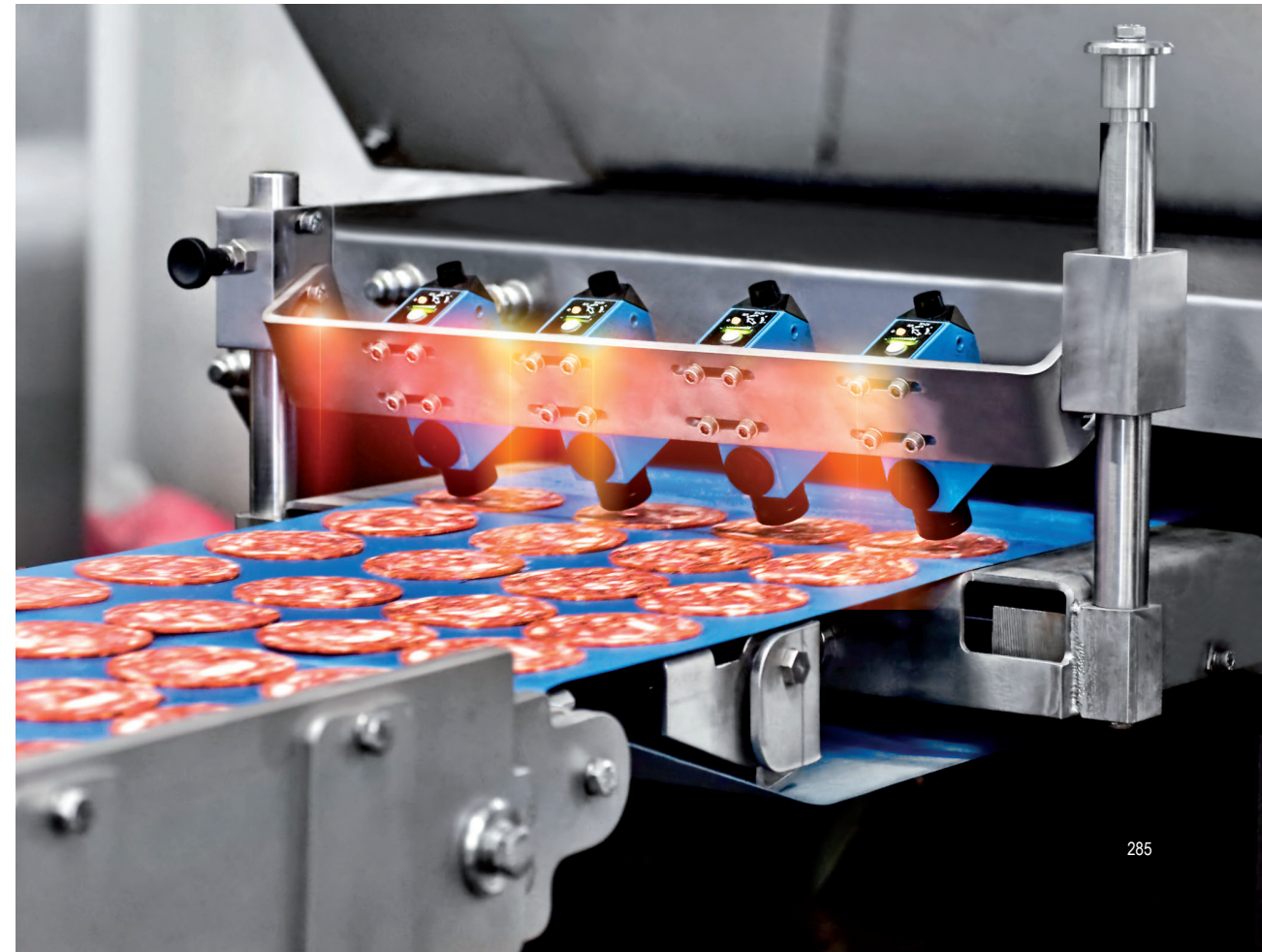


Shelf Life Stability of fermented sausages produced with the QDS Process[®] technology: US Pepperoni and German Salami case studies

Josep Comaposada, Jacint Arnau, Josep M^a Monfort
IRTA

Daniel Sanz, Llorenç Freixanet, Josep Lagares
Metalquimia, S.A.U.



In order to assess the effect of the QDS process drying in the product stability of two kinds of raw fermented sausages (Pepperoni and German Salami), two Shelf Life Studies were conducted and different aspects analyzed: TBARS analysis (μg of Malonaldehyde per gr of sample), Instrumental colour (CIE L^* a^* b^* colorimeter) and overall appearance and sensory analysis (trained panel). Additionally, a photographic control was conducted.

The results revealed that the behaviour of both control and QDS samples was similar during the Shelf Life Study of both kinds of products, with low contents of Malonaldehyde in the TBARS analysis at the end of the tests, and no major changes in the sensory evaluation. Only in the Instrumental colour control some reduction in the colour was detected, with a small reduction of the L^* and a^* values of the Pepperoni and a lower a^* value for the German Salami. In any case the reduction was equal for the control and the QDS product.

INTRODUCTION

One of the major concerns about the shelf life stability of dry fermented sausages is the oxidation. This fact is mainly because of the high content of fat (usually higher than 25 – 30% in the end product) together with the use of salt, long time ripening and drying periods and, depending of the process, high temperatures in certain phases.

The Quick Dry Slice Process (QDS process[®]) is a new drying technology able to achieve the same drying losses as in the long standing stays in chambers of the traditional process, but just in within minutes (usually no more than 1 hour). In the QDS process[®] the product is sliced just before the drying step, and then the slices go through a continuous drying process in the QDS chambers, with controlled air flow, temperature and moisture.

While in the traditional processes the range of temperatures used during the drying phase may vary between 10 – 18°C, in the QDS process the usual range

of drying temperatures goes from 25°C to 35°C. Another difference is the moisture content of the circulating air, while a normal range in the traditional process could be 60 – 75% depending on the phase, in the QDS process it doesn't exceed the 20 – 40%. The actual temperature of the slice does not exceed 16 – 22°C as the high speed of water evaporation keeps the slice fresh due to the loss of heat with the extracted water steam.

In order to determine if this major exposure to air and temperature could negatively affect the stability of the end product through its shelf life, several shelf life studies were conducted of different traditional products from different parts of the globe. The chosen products were a Pepperoni produced in the USA and a German Salami produced in Germany.

Material and Methods

Both products were produced in the standard way each company normally does using the standard fermentation steps, and before getting the batch into the drying chambers, a representative sample of product was vacuum packed log by log, half frozen (-5°C), and shipped to the CENTA Meat Research Center of IRTA (Institute for Agricultural Technology Research) in Monells (Spain). All the samples were kept at -5°C until the moment they were sliced for drying in order to avoid any further development of the product that could affect the final result of the studies.

Once the product was dried in the QDS it was immediately packed. The shelf life study was conducted in the CENTA-IRTA facilities, keeping it the same time as the standard declared shelf life of each kind of product, and using as a reference the same amount of sliced traditional product packages produced from the same batter batch as the QDS samples.

In the case of the German Salami, it was packaged and shipped immediately after drying to the Hochschule Ostwestfalen-Lippe University of Applied Sciences in Lemgo (Germany), where the Shelf Life study was conducted.

Analyzed parameters

TBARS

The TBARS method determines lipid oxidation in food. The thiobarbituric acid reactive substances (TBARS) test determines the amount of malonaldehyde (MDA), a major secondary by-product of lipid oxidation in a sample. The absorbance of supernatant was measured at 532 nm. The MDA was determined according to the method of Botsoglou et al. (1994) adapted to the assay conditions. Because malonaldehyde (MDA) is the main oxidation product of polyunsaturated fatty acids (PUFA), the result is expressed as μg of malonaldehyde per gr of tissue.

Note: The TBARS values in fresh meat is usually <0.2; in adipose tissue < 1.0. (Blüchel, 2006)

Instrumental colour

The CIE Lab value was used as an indicator of the colour evolution throughout the period of storage. CIE Lab L^* , a^* and b^* (CIE Lab color system, CIE = Commission Internationale de l'Eclairage) values were determined as indicators of lightness, redness and yellowness, respectively. The measurements were done at the surface of three slices (the upper, middle and bottom) of the units.

The color measurement was carried out with a colorimeter from Minolta, the Chroma Meter CR-400. The Chroma Meter CR-400 is a reemissions colorimeter for measuring surface colours according to the three-range method. The D65 (daylight) was chosen, because its properties correspond to the natural daylight illumination. The measured values were converted into the control unit in the L^* a^* b^* values.

Overall appearance and sensory analysis

In order to determine the organoleptic alterations the different product could present during the whole shelf-life study, different samples were kept at controlled conditions and sensory evaluated at different times of

the study. Each QDS processed sample was compared to a conventionally processed sample kept in the same conditions.

Because of the specific characteristics of each product, slightly different parameters were evaluated in each case. Each sensory analysis performance is described in the case study sensory evaluation point.

Photographic evolution

In addition to the controlled parameters, the evolution of the appearance of the products was recorded taking pictures of the slices every control time during the whole Shelf Life Study.

Case study 1: US Pepperoni Shelf Life study

The product was prepared by mixing pork lean and fat, together with beef lean and fat. The standard recipe of the factory was used. After fermenting the logs below a pH of 4.7, the product went through a thermal process, achieving 53°C in the core during no less than 1 hour. Afterwards, product was chilled and the logs used for the QDS process were vacuum packaged individually and half frozen at -5°C.

The average fermentation, cooking and cooling loss was $5.49 \pm 1.114\%$ of the initial weight of the stuffed product.

Slices of 7.5 ± 0.12 g for QDS process[®] were obtained from "Pepperoni". Drying time was 23 min at 25 °C, 3.5 m/s air speed and 35-37 % of relative humidity until $19.3 \pm 1.25\%$ of drying weight loss was reached (MPR below 1.6, according to USDA Standards). The initial temperature of the slices was 1.7 ± 0.5 °C, while at the end of the drying process it was 19 ± 1 °C. The average weight of the dried slices was 6.0 ± 0.14 g.

Both traditionally dried and QDS process[®] dried slices were packaged in MAP, using 100% N₂ gas composition and with residual oxygen below 0.3%. All the samples were kept for 180 days, as the standard declared shelf life of the product.

The parameters analyzed at IRTA were:

- Thiobarbituric acid (TBA)
- Instrumental colour analysis (L*, a* and b*)
- Sensory analysis (appearance, colour, odour)
- Photographic evolution

The packs of each sample were separated into two groups, one was stored at an average temperature of 3°C and the other group was stored at -3 °C and was used as a reference standard (Control). The units were kept in a storage box to keep the samples in dark conditions during storage. The temperature in both boxes was recorded throughout the whole study with a data logger MicroLog-Fourier Systems LTD to monitor the temperature of the samples.

During the shelf life study the samples were controlled at certain times for the different parameters: day 0, 14, 28, 50, 80, 90, 110, 120 and 180.

Pepperoni shelf life study results

TBARS

The evolution of the amount of Malonaldehyde (MDA) in both control and QDS products was similar during the whole shelf life study, with no significant differences in the final content of MDA.

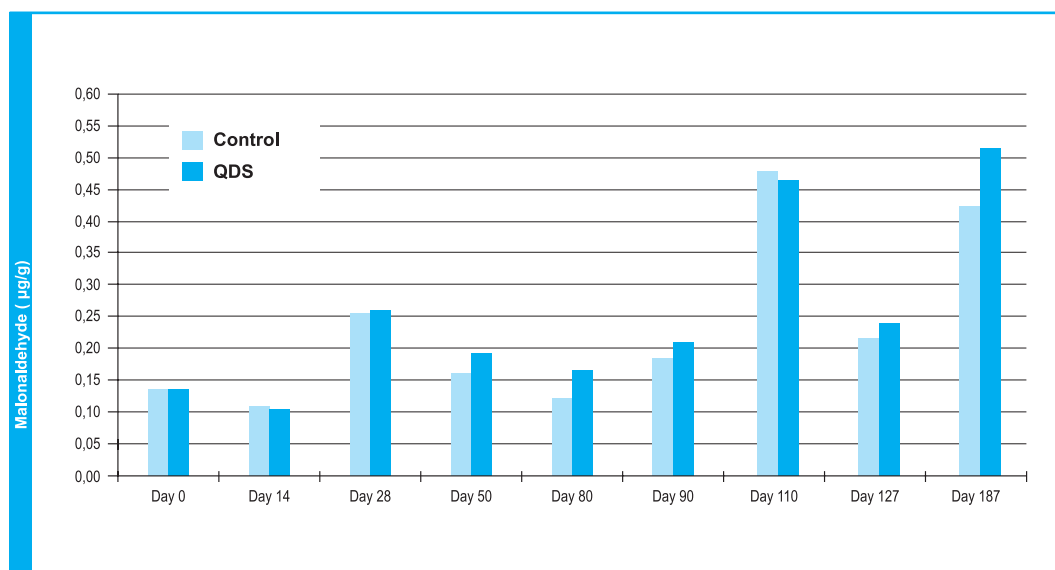
Instrumental colour

The evolution of the measured instrumental colour is very similar in the control and the QDS dried product. As can be seen, there was a slight reduction in the L* and a* parameters (lightness and redness) in the control and in the QDS product, at the end of the shelf life study.

Overall appearance and sensory analysis

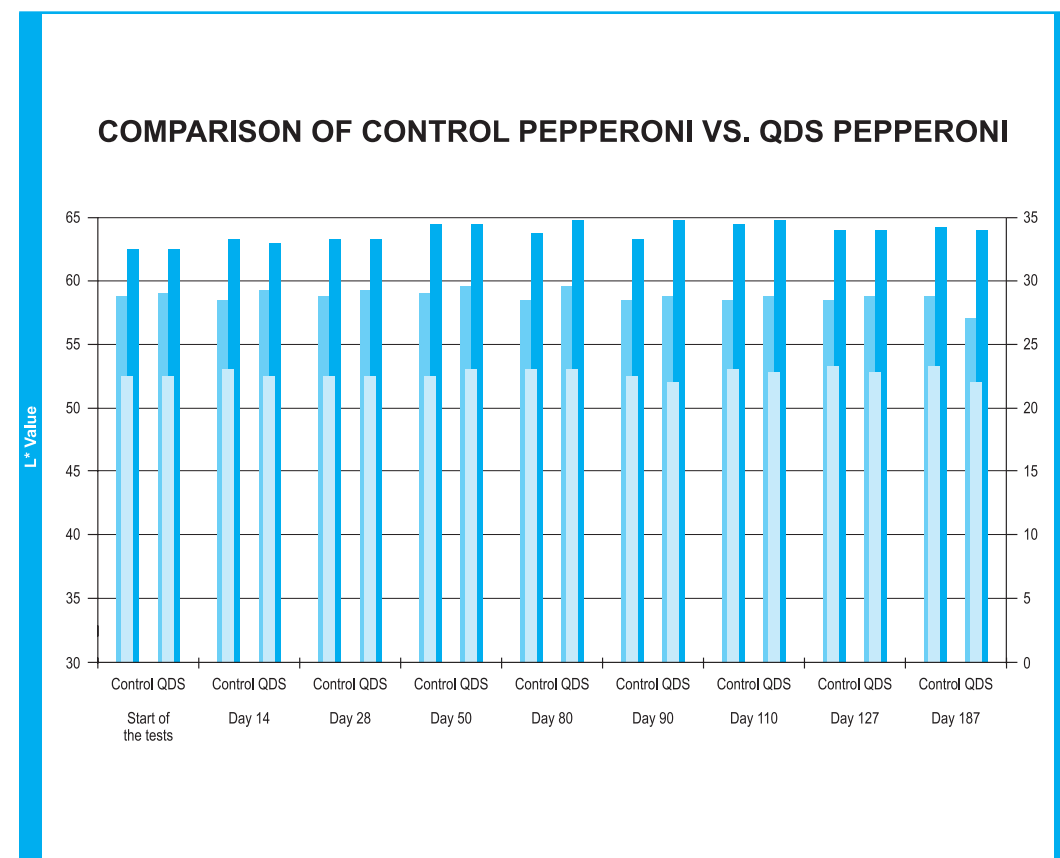
The sensory analysis was performed by three selected and trained assessors. The guideline for the

FIGURE 1 Malonaldehyde (MDA) concentration in Pepperoni samples



▲ Figure 1. Malonaldehyde (MDA) concentration in Pepperoni samples.

FIGURE 2 Evolution of instrumental colour parameters in Pepperoni



▲ Figure 2. Evolution of instrumental colour parameters in Pepperoni.

descriptors was carried out by open discussion in two previous sessions. The descriptors retained were: rancid odour (basic odour sensation elicited by pork fat having an unpleasant stale taste or smell as the result of decomposition), acid odour (intensity of odour of dry products having characteristics of an acid), colour appearance (visual sensation elicited by pork fat according to the characteristic colour of each product).

In the “Pepperoni” fat, the colour appearance can turn from red (standard condition) to white (unacceptable condition) with increasing storage time. If the lean

meat colour turns to white, is also considered negative. Differences in texture were also evaluated, mainly related to the slice cohesiveness (tactile texture attribute related to the strength of the slice).

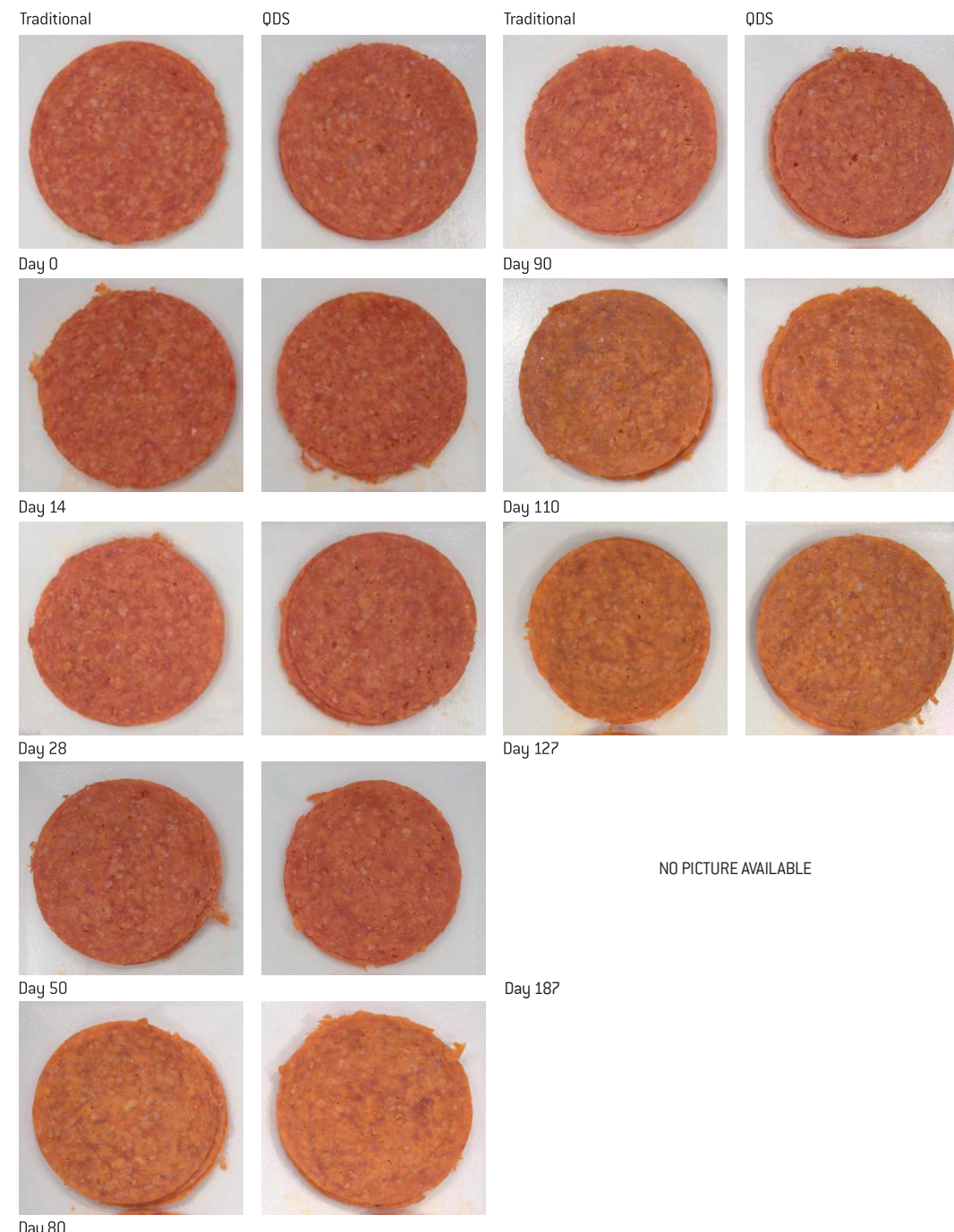
The sensory analysis evolution of the QDS product compared to the control product ended with no significant differences, and without any apparent rancid odour. Colour and appearance grading was lower at the end, due to a loss of brightness and redness of the colour which was also recorder by the L* a* b* instrumental colour measurement.

TABLE 1 Comparative evaluation of sensory parameters of "Pepperoni" samples of QDS product at 3°C and -3°C (reference). Scale from 1 to 7.

DAY		OVERALL APPEARANCE	COLOUR	ODOUR	TEXTURE
DAY 0	Score				
	Obs.			Clear "acid" odour and absence of rancid odour	
DAY 14	Score	7	7	7	7
	Obs.			Clear "acid" odour and absence of rancid odour	
DAY 28	Score	7	7	7	7
	Obs.			Clear "acid" odour and absence of rancid odour	
DAY 50	Score	6,5	6,5	7	7
	Obs.	Very slight differences in orange colour. Higher in traditional samples		Clear "acid" odour and absence of rancid odour	
DAY 80	Score	7	7	6	7
	Obs.			Moderate "acid" odour and absence of rancid odour in both samples. Slight cured odour in QDS	
DAY 90	Score	7	7	6,5	7
	Obs.			Moderate "acid" odour and absence of rancid odour in both samples. Slight cured odour in QDS	
DAY 110	Score	6,5	6,5	7	7
	Obs.	Very slight differences in fat odour in QDS	Slight white colour in traditional samples probably due to a higher fat content of slices	Lower "acid" odour and absence of rancid odour	
DAY 127	Score	7	7	6,5	7
	Obs.			Slight acid odour in QDS samples. Absence of rancid odour	
DAY 187	Score	5,5	5,5	6,5	7
	Obs.			Absence of rancid odour	

▲ Table 1. Comparative evaluation of sensory parameters of "Pepperoni" samples of QDS product at 3°C and -3°C [reference]. Scale from 1 to 7.

Photographic evolution



▲ Table 2. Pictures of "Pepperoni" during the shelf-life study.

Case study 2: German Salami Shelf Life Study

The average fermentation, smoking and cooling loss was 4,44% of the initial weight of the stuffed product.

Slices of 14.5 ± 0.15 g for QDS process® were obtained from “German Salami”. Drying time was 42 ± 2 min at 30 °C, 3.5 m/s air speed and 30-37 % of relative humidity until 22.5 ± 0.4 % of drying weight loss was reached. The initial temperature of the slices was -3.4 ± 0.5 °C, while at the end of the drying process it was 21 ± 1 °C. The average weight of the dried slices was 11.5 ± 0.15 g.

Both traditionally dried and QDS process dried slices were packaged in MAP, using 80% N₂ : 20% CO₂ gas composition and with residual oxygen below 0.3%. All the samples were kept for 54 days, as the standard declared shelf life of the product.

The parameters analyzed at Hochschule Ostwestfalen-Lippe University of Applied Sciences in Lemgo were:

- Thiobarbituric acid (TBA)
- Instrumental colour analysis (L*, a* and b*)
- Sensory analysis (appearance, colour, odour)
- Photographic evolution

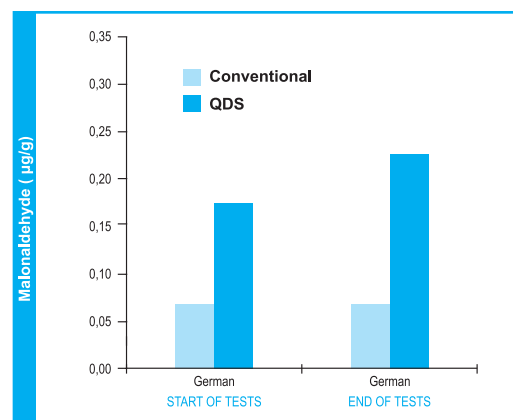
The packs of each sample were stored in chiller cabinets and were subjected to a storage test of daylight and night simulation (12 h light / 12 h dark). The temperature control of the chillers was on average 6°C, the light intensity corresponded to 300 LUX.

The control time for each sample was at the arrival of the product, day 7, day 14, day 21, day 28 and at the end of the declared shelf life.

The conventionally dried samples arrived later from the conventional drying chambers in the Meat Technology lab and underwent the same time for the light storage test.

TBARS

FIGURE 3 Malonaldehyde (MDA) concentration in conventional and QDS dried German Salami



▲ Figure 3. Malonaldehyde (MDA) concentration in conventional and QDS dried German Salami.

The content of MDA in the conventionally dried and in the QDS dried slices was very similar at the end of the shelf life study compared to the start of the tests. The final MDA content in the QDS product was slightly higher at the end, but still in a very low range for this kind of products.

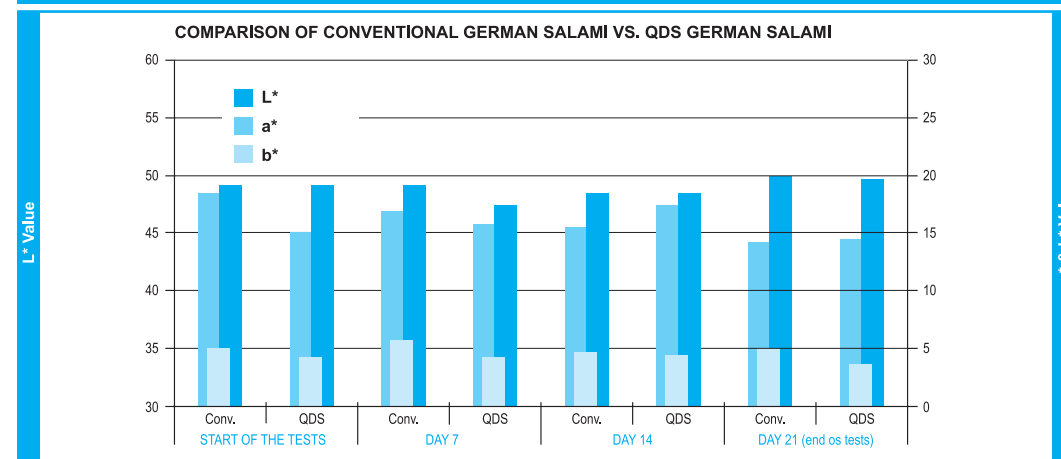
Instrumental colour

The levels of L* and b* (lightness and yellowness) didn't change too much during the whole shelf life study and were very similar in the conventional and QDS product. There was a slight reduction of the a* parameter (redness) at the end of the tests in both kind of samples.

Overall appearance and sensory analysis

The assessment was based on the DLG Test scheme for raw sausages (DLG-Prüfschema für Rohwürste) with a five-point scale and one evaluation table. The parameters evaluated in the meat product were: 1. Overall appearance, 2. Aspect, colour, colour retention, composition, 3 Consistency and 4. Smell and taste.

FIGURE 4 Colorimetric (L*a*b) evolution of the QDS product vs. Conventional product.



▲ Figure 4. Colorimetric (L*a*b) evolution of the QDS product vs. Conventional product.

These four areas are evaluated on a graded scale from 0 to 5, multiplied by a weighting factor and added to an overall evaluation. The result is finally divided by the sum of the weighting factors, which had been previously multiplied by the individual ratings, leading to the final quality number.

Beyond a certain classification of quality grading, the DLG tested products can obtain a Golden (5.00), Silver (4.50 to 4.99) or Bronze (4.00 to 4.49) DLG Award rating.



TABLE 3 Overall appearance and sensory evaluation evolution of QDS product vs Conventional product.

CONTROL DAY	PRODUCT	OVERALL APPEARANCE (x1)	ASPECT, COLOUR, COLOUR RETENTION, COMPOSITION (x 3)	CONSISTENCY (x 2)	FLAVOUR AND TASTE (x4)	QUALITY GRADING DLG
DAY 0	Conv.	5	4 porous	5 edge slightly dry, without definition	4 sour	4,3 Bronze
	QDS	5	5	5 rough slice, without definition	4 sour 3 characteristic dry sausage flavour missing	4,2 Bronze
DAY 7	Conv.	5	4 porous 4 Too much collagen tissue	5	5	4,4 Bronze
	QDS	5	5 blurred surface, without definition	5 rough slice, without definition	4 sour 4 characteristic dry sausage flavour missing	4,2 Bronze
DAY 14	Conv.	5	4 porous 4 Too much collagen tissue	5	3 sour, not spoiled	3,6 No award
	QDS	5	5	5 rough slice, without definition	5	5 Gold
DAY 21	Conv.	5	4 porous 4 Too much collagen tissue	5	3 soup, not spoiled	3,6 No award
	QDS	5	5	5 rough slice, without definition	5	5 Gold
DAY 28	Conv.	No control (Christmas Holidays)				
	QDS	5	5	5 rough slice, without definition	5	5 Gold
DAY 33	Conv.	5	4 porous 4 Too much collagen tissue	5	3 soup, not spoiled	3,6 No award
	QDS	No control (Christmas Holidays)				
DAY 54	Conv.	5	4 porous 4 Too much collagen tissue	5	3 soup, not spoiled	3,6 No award
	QDS	5	5	5 rough slice, without definition	5	5 Gold

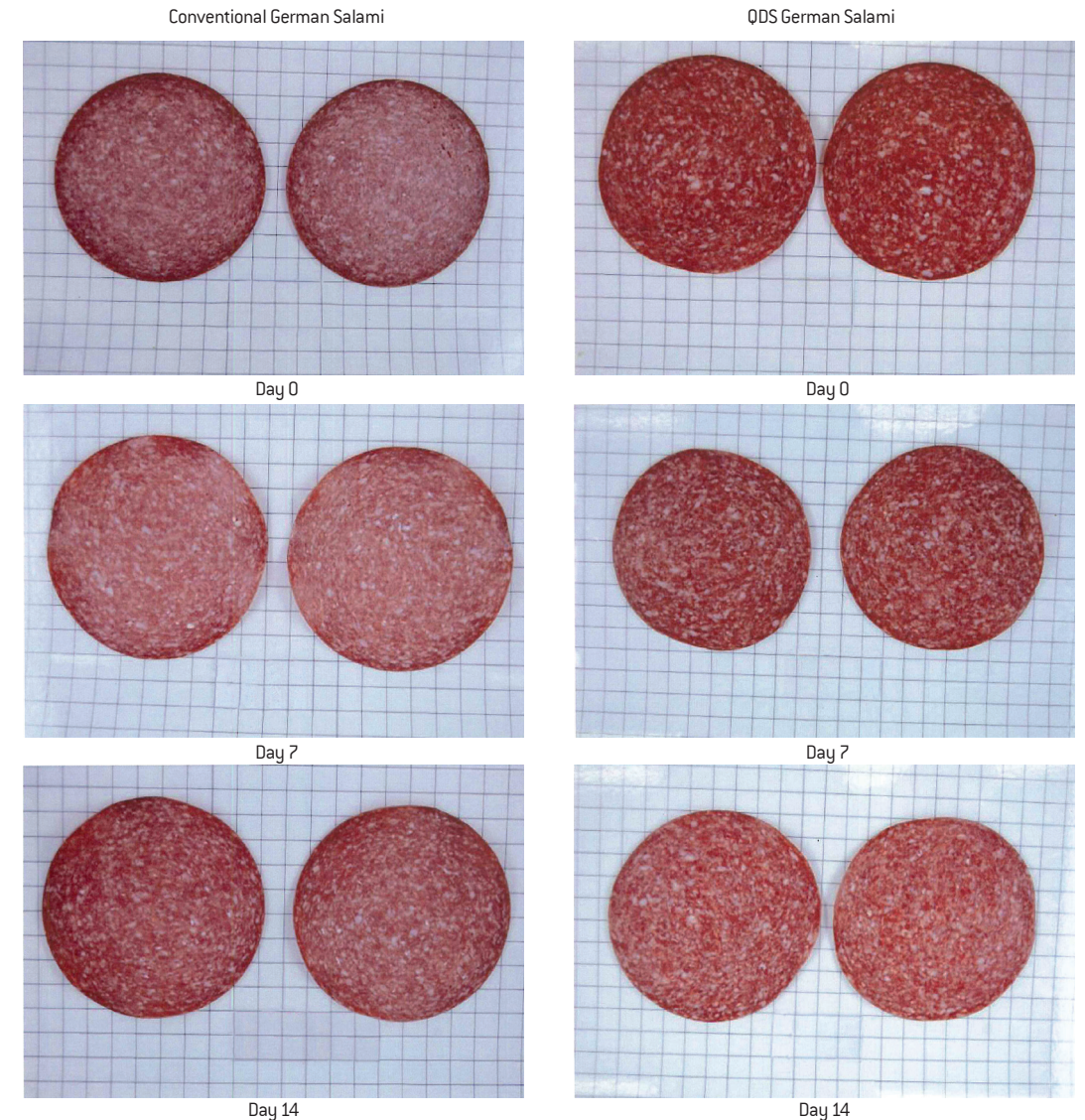
▲ Table 3. Overall appearance and sensory evaluation evolution of QDS product vs Conventional product.

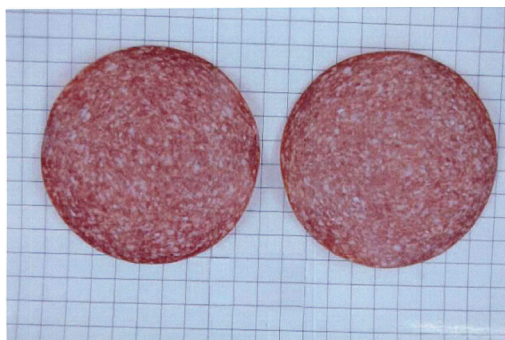
The sensory evaluation of both products was very similar at the beginning of the study, but the conventional German Salami developed some

sourness at the half of the shelf life study, reducing its final grading compared to the QDS German Salami.

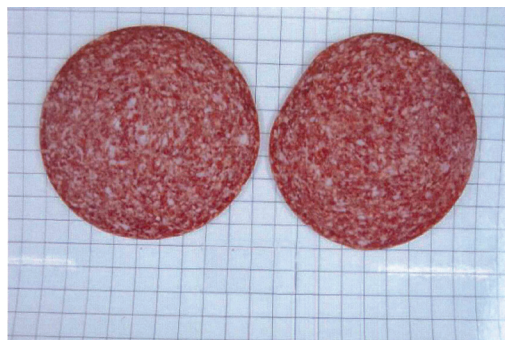
Photographic evolution

▼ Table 4. Visual comparison of the QDS product vs. Conventional product.





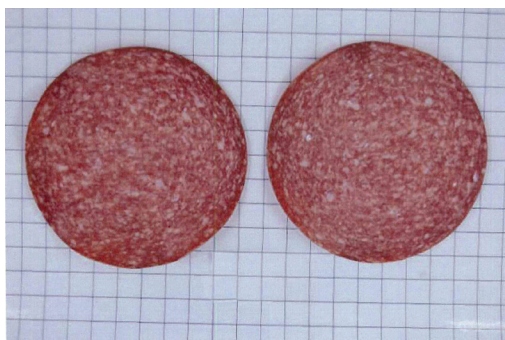
Day 21



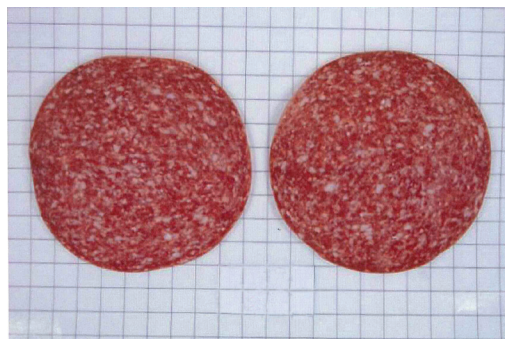
Day 21

NO PICTURE AVAILABLE

Day 28



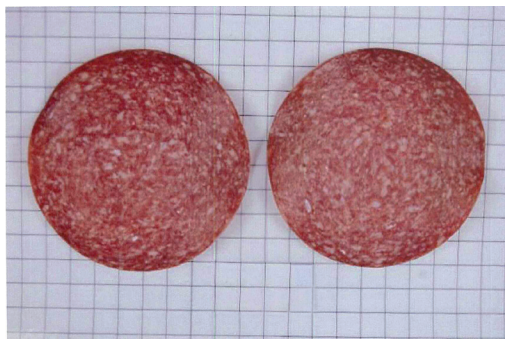
Day 33



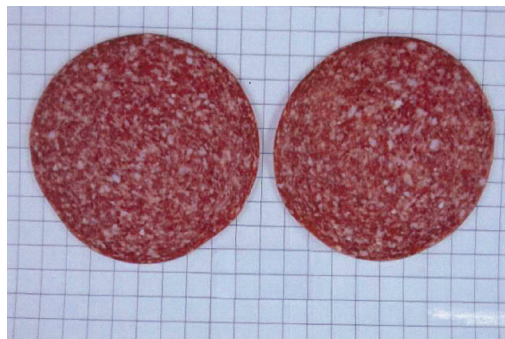
Day 28

NO PICTURE AVAILABLE

Day 33



Day 54



Day 54

CONCLUSIONS

In both case studies the evolution of the product during the whole shelf life was very similar for the control product and the QDS process[®] dried product.

The evolution of the rancidity in the Pepperoni product, according to the results obtained from the TBARS analysis, was very similar for the control and the QDS samples. In the sensory analysis a rancidity odour couldn't be noticed after the whole shelf life study in the QDS samples, nor in the control samples.

In the German Salami samples the conventional and QDS product had a very similar level of MDA in the TBARS analysis after the whole shelf life study.

The overall appearance and sensory analysis of the Pepperoni revealed a similar evolution of the control and the QDS samples during the whole shelf life. The most affected parameter was the colour (mainly red colour due to the paprika) and so the overall appearance, which were graded lower at the end of the study (but still acceptable) in both control and QDS samples, while the rest of parameters kept a similar grading during the whole study.

This change in the colour and appearance was also recorded by the instrumental colour control that revealed a reduction in the L* and a* parameters (lightness and redness), due to the storage time, but still with an acceptable level for control and QDS Pepperoni samples.

In the German Salami case, there was also a similar reduction in the colour for the conventional and QDS samples, but in this case only in the a* parameter (redness), while the L* and b* kept a similar result until the end of the study.

Finally, at the end of the overall appearance and sensory analysis of the German Salami it was noticed by the panellists that the conventional samples presented a sourness which reduced the final grading

of the overall quality, preventing the achievement of a DLG-Preis award.

It can be concluded that for these two specific products, in the way the samples were obtained and stored, the behaviour in terms of shelf life stability was equal for the QDS process[®] dried product and the control or conventional product.

As has been observed in previous studies (Comaposada, 2007), the fast technology of the QDS process[®] for drying non-dried fermented slices of raw sausages with high speed circulating air at controlled conditions, doesn't introduce major changes in the stability of the end product when compared to the standard control product in a Shelf Life study.

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