Development of new formats and products

Fast drying of dry-cured meat products applying the Quick-Dry-Slice (QDS) process technology

In the manufacture of dry-cured meat products by traditional methods, the drying stage is the most time intensive-process. A new technological procedure has been developed to reduce the production time and to maintain the traditional character and safety of the dry fermented meat products concurrently. Microbiological as well as sensory traits of the products are presented.

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In the manufacture of dry-cured meat products by traditional methods, the drying stage is the most time intensive-process. The traditionally used drying methods require this stage to have a duration of three to six weeks in the case of fermented sausages, depending on the diameter and characteristics of the product. In the case of dry-cured hams, the required times can vary from three to twenty-four months or more, depending on the product properties. During the drying and maturing phase, the product undergoes a dehydration process that is accompanied by a series of biochemical reactions produced by endogenous and microbial enzymes, which break down lipids and proteins to confer the product its characteristic texture and flavour. Any deviations from this process may result in consistency, colour and flavour defects. These deviations can be caused, to some extent, by the drying systems used. In conventional dryers, nozzles located in a series of perimeter conduits inject dry air and the humid air is returned through a series of centrally mounted conduits located on the ceiling of the drying chamber (COMAPOSADA, 1992; ATANASIO, 2001; TABERNA, 2003). The design of these dryers causes the air passing over the meat products located next the nozzle exits to have different properties than the air passing over the products in other parts of the dryer.

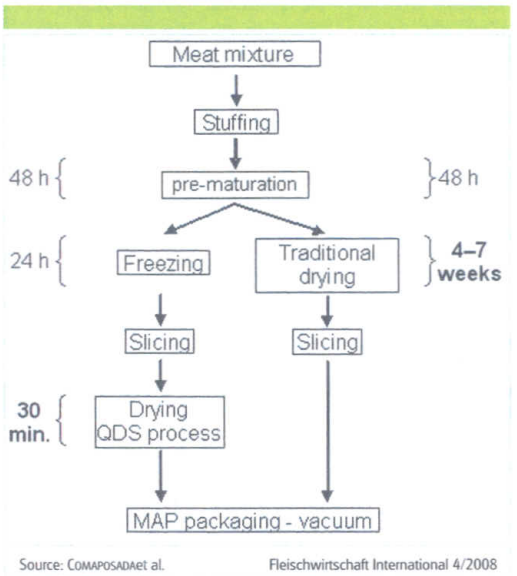


Fig. 1: Time comparison between the traditional drying process and the process using QDS technology for drying dry-cured meat products with a diameter of approximately 80 mm.

In order to reduce production costs and improve the quality of the final product, a study has been initiated looking at the mechanisms involved in the drying process, which present as limiting factors the resistance of the meat to the flow of water as well as the distance that the water must travel until it reaches the surface of the product in order to be extracted (CRANK, 1975). The objective of this study is the evaluation of a drying process for slices of meat products after fermentation, where the drying process consists of a convection phase followed by a vacuum drying phase (Quick-Dry-Slice process).

Drying technology based on the "Quick-Dry-Slice process"

Quick-Dry-Slice (QDS) drying technology is based on the drying and maturing method for sliced products proposed by ARNAU et al. in 2004. In this method, the sausages are subjected to a fermentation step until they attain the required pH. They are then frozen, sliced and subjected to a process comprising a convective drying stage and a subsequent vacuum drying stage. With this process it is possible to obtain the desired water content and texture in just 30 minutes (Fig. 1).

The QDS system

The QDS system developed by Metalquimia S.A. (Fig. 2) was designed with continuous production in mind. The system consists of a charging zone for frozen slices, a tempering and pre-drying zone with forced air circulation and a vacuum drying zone in which the required moisture is extracted from the slices. Finally, and depending on the exit temperature of the slices, the product is tempered again prior to being

No difference regarding water activity

Tab. 1: Average losses obtained for the different drying processes and pH of salchichón sausages at different sampling times

Drying process	Batch	Diameter	Drying time in days	Drying losses %	a_w End of drying	pH Before drying	pH End of drying	pH 3 month storage 1 °C	pH 3 month storage 13 °C
Traditional	1	80	38	28.6	0.907	5.32	4.89	5.00	4.70
	2	80	38	26.5	0.917	5.21	4.85	4.99	4.63
QDS	1	80	<1	30.7	0.902	5.32	5.25	5.14	4.99
	2	80	<1	32.8	0.887	5.21	5.15	5.20	5.15

Source: COMAPOSADA et al. Fleischwirtschaft International 4/2008

packaged in order to prevent condensation or adherence of fat to the packaging. The slices are placed on a stainless steel belt designed to facilitate the extraction of moisture from the slices, both during drying by forced convection and during the vacuum drying phase. The air used for drying and tempering during the forced convection stage is purified by means of a high efficiency particulate air (HEPA) filter in order to minimise contamination of the air coming into contact with the product. In addition, the speed of the tempering and drying process can be adjusted by controlling the temperature, relative humidity and velocity of the air passing over the product. The vacuum drying stage is controlled mainly via the operating pressure and the heating temperature. The different parts of the process are linked with one another by means of conveyor belts and slice loading/unloading mechanisms. The complete process is controlled by a PLC, which additionally enables monitoring and recording of the control parameters.

Microbiological and sensory evaluation

A number of studies were carried out to compare the safety and the sensory properties of the dry-cured meat products produced by the traditional method with those produced by the QDS process. In these studies the microbiological quality of "salchichón" sausages was evaluated after determination of the following parameters: bacterial counts of *Staphylococcus aureus*, sulfite-reducing clostridia, *Escherichia coli* and *Listeria monocytogenes*. In addition, the presence/absence of *Salmonella* was also investigated in 25 g samples. The study also included the measurement of the pH of the products at different sampling times, as well as the water activity of the final product.

The pH of salchichón sausages dried by the traditional method was lower than that of those dried by means of the QDS process (Tab. 1). Moreover, an additional reduction of the pH was also observed in salchichón sausages stored at 13 °C, an effect that was not found at 1 °C.

The results of the microbiological analyses and the *Staphylococcus aureus*, sulfite-reducing clostridia and *Escherichia coli* counts for each sampling time are shown in Tables 2, 3 and 4, respectively. The results thus show that both drying processes (traditional and QDS), as well as the subsequent storage of the vacuum-packed slices of salchichón sausage, achieve similar results in terms of reducing the number of microorganisms below the detection limit.

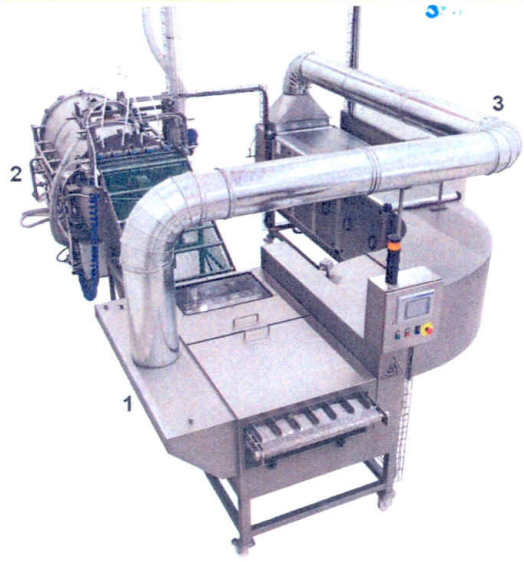
As to the prevalence of *Salmonella* in the salchichón sausages, it was observed that in the case of a raw material contaminated with this pathogen (presence in 25 g) prior to drying, the presence of *Salmonella* could still be detected in the 25 g sample of the final product, regardless of the process followed (traditional or QDS). The studies carried out by SMITH et al. (1975a, 1975b) report the incidence of dry-cured meat products showing the presence of *Salmonella* in those cases where the traditional drying method was used. The study concludes that in the cases where the pathogen is present after the pre-maturation stage, it is difficult to guarantee its absence in the final product by the reduction of the water activity, which takes place during the drying process. In view of these problems and in compliance with the Commission Regulation (EC) No. 2073/2005 on microbiological criteria for foodstuffs, which requires the absence of *Salmonella* in a 25 g sample for these types of products, the QDS process facilitates the integration of elements that inactivate this microorganism and could therefore improve the safety of the dry-cured meat product. To evaluate this possibility, a very low dose (<3 MPN/g) of *Salmonella* was inoculated and 2 g/kg of sodium acetate were added under controlled conditions to the mixture to be

QDS microbiologically safe

Tab. 2: *Staphylococcus aureus* (log cfu/g) counts in salchichón sausages depending on the drying process

Drying process	Batch	Before drying	End of drying	Storage 15 days 4 °C	Storage 3 months 1 °C	Storage 3 months 13 °C
Traditional	1	1.94	<1.00	<1.00	1.10	<1.00
	2	2.26	1.03	<1.00	<1.00	<1.00
QDS	1	1.94	1.77	<1.00	<1.00	<1.00
	2	2.26	1.91	1.27	<1.00	1.10

Source: COMAPOSADA et al. Fleischwirtschaft International 4/2008



Source: COMAPOSADAet al. Fleischwirtschaft International 4/2008

Fig. 2: The QDS system: 1. Tempering and pre-drying section; 2. Vacuum drying section; 3. Air purification circuit with HEPA filter

processed by the QDS method. The QDS process showed better results (greater number of 25 g samples showing an absence of the pathogen) than the conventional process (GARRIGA et al., unpublished results). These preliminary results will be validated in future investigations. It is important to emphasise that there are complementary technologies, such as those based on high pressures, which have provided satisfactory results in minimising the risk when applied to sliced products (GARRIGA et al., 2003).

The *Listeria monocytogenes* counts carried out in all the salchichón sausages analysed were all below the detection limit (<20 cfu/g) for all the sampling times (end of pre-maturation, end of drying and storage). It can hence be concluded that, starting from raw materials having low counts of the pathogen in question, it is possible to produce safe dry-cured meat products in compliance with the Commission Regulation (EC) No. 2073/2005 on microbiological criteria for foodstuffs, which limits the *L. monocytogenes* counts to <100 cfu/g for this type of products.

In order to further investigate the effects of QDS drying on raw materials contaminated with *L. monocytogenes*, an experiment was conducted in which the pathogen was inoculated under controlled conditions. In this experiment, the initial meat mass was first inoculated with a mixture of 5 different cultures of the pathogen, with counts in the order of $3x10^3$ cfu/g. It was then subjected to the fermentation and maturation/drying processes by both the traditional and the QDS methods. In both cases, similar reductions in the pathogen counts were achieved, which shows that the QDS process is an efficient process with respect to food safety.

With regard to the sensory evaluation, the slices of products made by the QDS process presented a less acidic aroma and taste than those made in the traditional manner (Tab. 5). This can be attributed to the lack of acidification during drying and the absence of an acidity gradient between the external and the internal parts of the slice. In addition, the volatile acids may have been partially eliminated during the drying stage. For this reason, in the QDS process, the pH may decrease to values below those of the conventional process during pre-maturation. The colour was also found to be more intense in the case of the QDS process, because the intensity of the colouring agent Ponceau 4R was not reduced during the process. The flavour of the product produced by the traditional method was more balanced and it was therefore nec-

Same results with both processes

Tab. 3: Sulfite-reducing clostridia (log cfu/g) counts in salchichón sausages depending on the drying process

Drying process	Batch	Before drying	End of drying	Storage 15 days 4 °C	Storage 3 months 1 °C	Storage 3 months 13 °C
Traditional	1	1.22	<1.00	<1.00	<1.00	<1.00
	2	1.46	<1.00	<1.00	<1.00	<1.00
QDS	1	1.22	<1.00	<1.00	<1.00	<1.00
	2	1.46	1.09	<1.00	<1.00	<1.00

Source: COMAPOSADA et al. Fleischwirtschaft International 4/2008

E. coli count not different after storage

Tab. 4: *Escherichia coli* (log cfu/g) counts in salchichón sausages depending on the drying process

Drying process	Batch	Before drying	End of drying	Storage 15 days 4 °C	Storage 3 months 1 °C	Storage 3 months 13 °C
Traditional	1	3.45	1.76	1.43	<1.00	<1.00
	2	3.45	1.86	1.62	<1.00	<1.00
QDS	1	3.45	2.97	1.47	<1.00	<1.00
	2	3.45	2.89	1.22	<1.00	<1.00

Source: COMAPOSADA et al. Fleischwirtschaft International 4/2008

QDS with less acidic aroma

Tab. 5: Evaluation of sensory parameters of salchichón produced by traditional and QDS method

Criteria	Drying process Traditional	QDS
Roughness	0.21[a]	2.33[b]
Colour	5.96[a]	6.67[b]
Flavour, cured	6.00[a]	4.50[b]
Acidity	5.00[a]	1.00[b]

Source: COMAPOSADA et al. Fleischwirtschaft International 4/2008

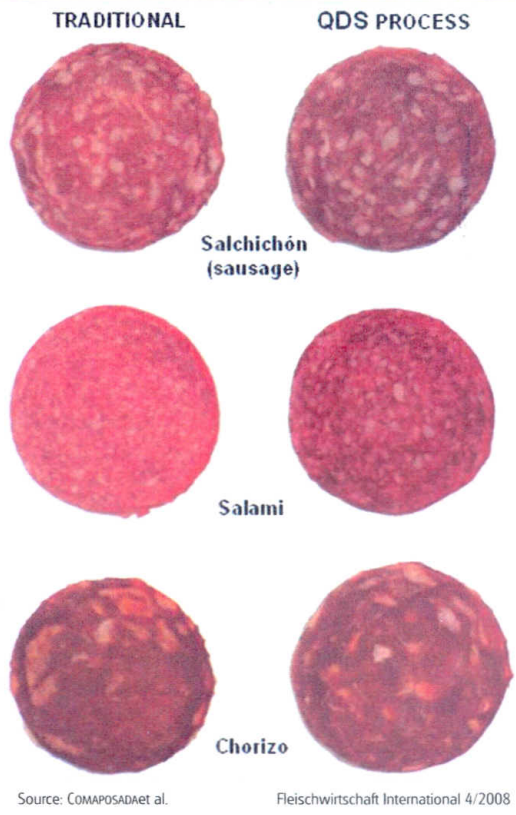
essary to modify the initial mixture of spices and flavouring agents in the case of the QDS process in order to obtain equivalent products in both cases. Similarly, slight differences in appearance were found depending on the product. Figure 3 shows various products obtained by both methods after vacuum-packing.

Advantages of the QDS method and technological challenges

For the commercialisation of dry-cured meat products in slices, QDS technology offers numerous advantages relative to conventional drying methods. It is necessary, at this point, to distinguish between advantages of a technological nature and those related to the operation and management of the production process. Among the technological advantages of the QDS process it is worth mentioning the ability to obtain products showing less acidic flavour and more homogeneity, as well as the possibility to obtain products with a higher pH. Furthermore, the products are free from fungi and product safety control is enhanced thanks to a more precise monitoring of the process and of the product itself. In addition, the application of the QDS process results in increased productivity and decreased residues.

With regard to the production process, the QDS method offers enhanced production flexibility, an increase in speed, the possibility to implement just-in-time systems as well as requiring less space than conventional methods.

The QDS process may contribute to the development of new formats and products in line with the trends and lifestyles of today's consumers, who demand ready-to-use products in a small format. It is also important to develop products aimed at especially sensible consumer groups (people with high blood pressure, elderly people, immune-depressed patients, diabetics, obese people etc.), as well as other types of products that will help achieving the objectives set forth by the NAOS strategy, which was agreed between the Public Administration (represented by the Ministry of Health and Consumer Affairs, Ministry of Industry, Ministry of Education and Science), the Spanish Food Safety Authority AESA, the Spanish Food and Drinks Federation FIAB together with the large food producers and the majority of the Health Departments of the Autonomous Communities of Spain, as an attempt to communicate the need to reduce the daily intake of fats and salt, among other things.



Source: COMAPOSADAet al. Fleischwirtschaft International 4/2008

Fig. 3: Visual comparison between salchichón, salami and chorizo sausages obtained by means of the traditional method and the QDS method after 7 days of storage in vacuum packs

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