Identification of control strategies to manage microbiological risks in typical pork products

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Abstract
Starting from 2009 a pilot project has been implemented by a local veterinary service of the Veneto region of Italy (AZ-ULSS 8) in collaboration with IZSVe (Istituto Zooprofilattico Sperimentale delle Venezie) with the aim of identifying control measures based on own-checks and official controls in order to manage microbiological risks related to traditional pork fermented sausages (Italian salami end soppresse) consumption.
According to the data obtained a control strategy based on microbiological tests performed by the Competent Authority (CA) and the monitoring of the weight decrease in sausages by the food business operator (FBO) has been implemented for 2010-2011 production season.

Introduction
In the Veneto region of Italy the production of traditional pork fermented sausages, salami and soppresse in particular, has significantly increased in the last four years, after specific regional legislation has been issued in this field starting form 2007. In particular in 2008 a specific regional legislation has entered into force mainly focused in acquiring detailed information on technical and sanitary aspects of the production processes with the aim of identifying, within a two years period, control strategies to reduce the potential risks due to the consumption of salami and soppresse at acceptable level.
Although traditional processing techniques generally appear to be effective in pathogens control, a preliminary monitoring campaign showed that sausages ready to be marketed may in some exceptional circumstances be contaminated with foodborne pathogens, thus posing a potential risk for the consumers.
Additionally, data from a literary review demonstrate that both traditional and industrial sausages may be contaminated at the end of the fermentation period in particular with Salmonella spp., Listeria monocytogenes and E.coli O157 (Normanno G., et al., 2004; De Cesare et al. 2007; Bianchi D.M. et al., 2007). Furthermore food borne outbreaks have been associated to the consumption of traditional raw pork products typically submitted to a short ripening period (Pontello M., et al. 1998; Luzzi I., et al. 2007).
Thus with the aim of avoiding the marketing of potentially at-risk salami and soppresse produced within the Veneto region a study has been performed focused at identifying control measures easily applicable directly by the producers with the supervision and control of the CA.
According to the information obtained a control strategy based on official controls at the early stages of the production process and on the monitoring of the weight decrease in sausages by FBOs has been implemented. Results from this study have been used to update the legislation issued on this field (DRGV n.2280/2010).

Material and Methods
In order to collect detailed information on microbiological contamination of salami and soppresse at different point of the production process, from farm to fork samples have been collected in 2009-2010 production season according to two different sampling schemes "A" and "B" described in table 1. 32 producers registered according to relevant Veneto region legislation were included in the study.
Briefly the A sampling scheme was applied to all the producers both aimed at estimating the prevalence of selected food-borne pathogens (Salmonella spp., Campylobacter spp., E. coli O157, Listeria monocytogenes and spp.) in samples collected at different points along the production chain (animal, minced meat, products during ripening) and at collect-

ing information on the most influent parameters of drying and fermentation (pH, a_w, environmental conditions such as temperature and humidity).
The more intensive sampling scheme B was applied in a selection of four producers and was aimed at collecting additional data to evaluate also a possible correlation between the aw and the weight decrease of the sausages during maturation.

Table 1: sampling scheme A and B description

SAMPLING STAGE	SAMPLE TYPE	SAMPLING SCHEME A	LABORATORY ANALYSIS
ABBATTOIR	FAECES	1 pooled faecal sample all pigs per batch (1 batch includes a maximum of 3 pigs)	Campylobacter spp. and E.coli O157
	LYMPHNODES	1 pooled of lymphnodes all pigs per batch	Salmonella spp.
PRODUCTIVE UNIT	MINCE	250 grams of minced raw meat ready for stuffing	Campylobacter spp. , Salmonella spp. E.coli O157, Listeria spp. and Listeria monocytogenes; pH and aw
	SALAMI	2 salami (1selected batch) / productive unit both identified and weighted the first day of ripening and then sampled at 20 and 40 days of ripening . In case of positive batches sampling of 1 salame every 15 days up to two negative results for the identified pathogen	Campylobacter spp. , Salmonella spp. E.coli O157, Listeria spp. and Listeria monocytogenes; pH and aw
	SOPPRESSE	2 soppresse (1 selected batch) / productive unit both identified and weighted the first day of ripening and then sampled at 90 and 130 days of ripening. In case of positive batches sampling of 1 soppressa every 15 days up to two negative results for the identified pathogen	Campylobacter spp. , Salmonella spp. E.coli O157, Listeria spp. and Listeria monocytogenes; pH and aw
SAMPLING STAGE	**SAMPLE TYPE**	**SAMPLING SCHEME B**	**LABORATORY ANALYSIS**
PRODUCTIVE UNIT	SALAME FOR PRODUCTIVE UNIT A AND B; SOPPRESSA FOR PRODUCTIVE UNIT C AND D	identification and weight determination of all salami/soppresse the stuffing day Every Monday =aw, pH and weight determination + microbiological analysis Every Thursday= aw, pH and weight determination Two times a week weight determination of 4 identified salami/soppresse for all the ripening period	Campylobacter spp. , Salmonella spp. E.coli O157, Listeria spp. and Listeria monocytogenes; pH and aw

The two datasets deriving from A and B monitoring schemes were validated before the statistical analysis.

Results

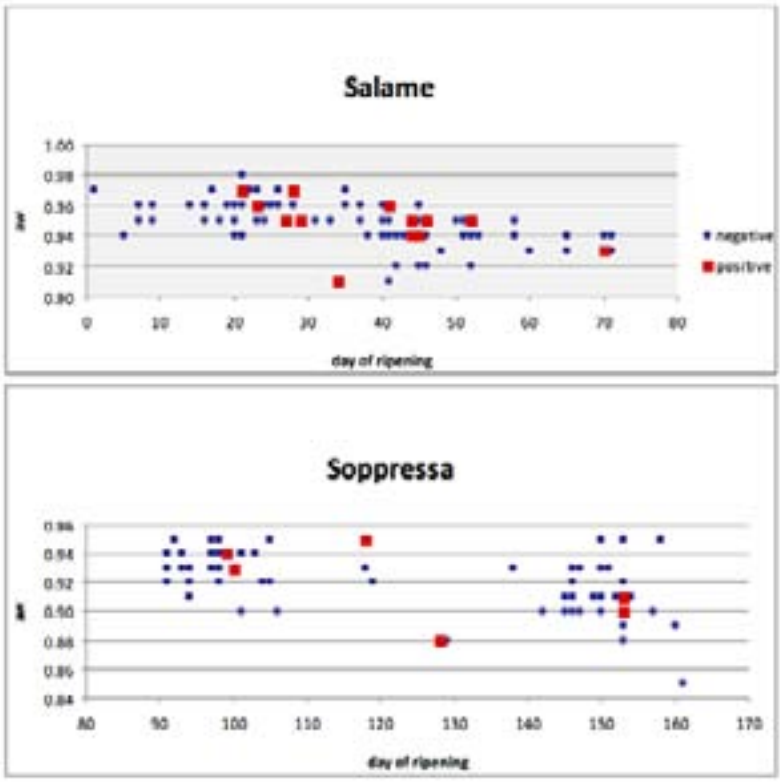
Sampling scheme A
128 pigs batches were slaughtered in 2009-2010 corresponding to a number of estimated sausages of 10.240 salami and 3.840 soppresse.
58 out of the 534 samples collected and analysed resulted positive to one or more foodborne pathogens as described in the table 2.

Table 2: Foodborne pathogens distribution, sampling scheme A

Sample	*Salmonella* spp.	*E. Coli* O157	*Campylobacter* spp.	*Listeria monocytogenes*	*Listeria* spp.
Faeces	6	0	7	0	0
Lymphnodes	2	0	0	0	0
Mince	1	0	0	17	16
Salame	2	0	0	8	4
Soppressa	0	0	0	5	1

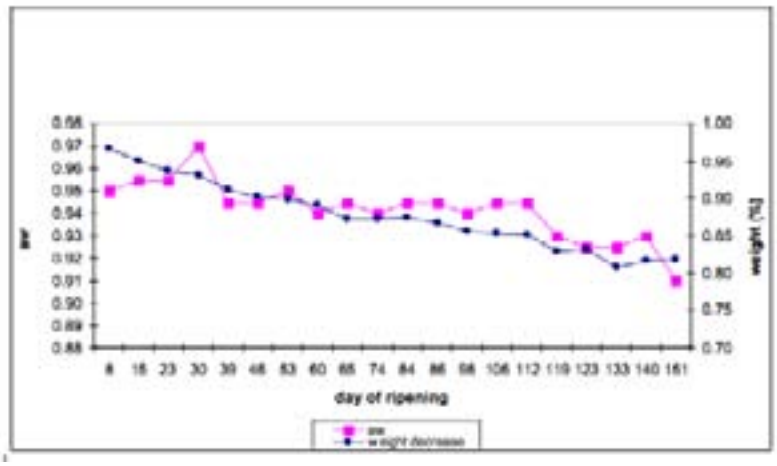
Out of the 30 soppresse sampled at the end of the ripening period (≥130 days of ripening,) two resulted positive for Listeria monocytogenes, both <10 ufc/gr and aw < 0.92. Out of the 56 salami at the end of the ripening period (≥40 days of ripening) 4 resulted positive for Listeria monocytogenes, all <10 ufc/gr and aw > 0.92.
In figure 1 the distribution of aw values registered for salami and soppresse (all the batches) respectively are reported according to the day of ripening.

Figure 1: aw distribution for salami and soppresse



Sampling scheme B
Data from this intensive sampling scheme were analysed in order to evaluate possible correlation between the aw and the weight decrease of the sausages during ripening.
In figure 2 a graph describing the decrease in aw and weight according to the day of ripening for productive unit C is reported.

Figure 2: Sampling scheme B, productive unit C: aw and weight trend



Data related to pH and environmental conditions were analysed but are not reported.

Discussion

Data from sampling scheme A revealed a very low percentage of positive sausages tested positive for Listeria monocytogenes at the end of the ripening period, moreover the level of contamination was always below 10 ufc/gr. aw value seems to be very critical particularly for salami and consistently dependent on the productive unit: the aw value was below 0.92 (not favourable to microbiological growth of Listeria monocytogenes according to Regulation CE 2073/2005) only in a small proportion of salami at the end of the ripening period. Data from sampling scheme B allowed to correlate with a good approximation a weight decrease of at least 25% to an aw decrease equal or below 0.92 both for salami and soppresse.

Conclusion

In 2010 a regional legislation has been published defining that only salami and soppresse, intended to be eaten raw, with an aw value below 0.92 may be marketed to the final consumer.
According to the data obtained a control strategy was defined based on the identification of positive/negative batches by the CA and the monitoring of the weight decrease in sausages by FBO.
CA takes faecal samples form pigs at farm level and mince ready for stuffing for microbiological tests, in case of positive results further samples of sausages are analysed until negative finding; in fact only negative batches may be marketed. FBO monitors all the batches for the weight decrease and once the 25% weight loss is obtained one sausage is submitted to an official control in order to verify the compliance of aw value with regional legislation.

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