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ORAL COMMUNICATION

Survey on processing techniques of the meat native pigs: from raw meat to final traditional products

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SUMMARY

In Europe Mediterranean, Italy particularly, there is a long tradition of cured products made from pork meat. The products obtained from meat of native pigs and described as typical are often linked to ancient local traditions and the technical processing / preparation used can influence the final properties. During the survey, some of the techniques employed in the preparation of traditional salumi made from meat of *Nero Siciliano* and *Sarda* breed were analyzed. The preparation of salami and sausages was conducted at some artisan laboratories located in the traditional area of Sicily (*Nebrodi* mountains) and Sardinia, according to techniques in use in rural traditions. The mixtures were prepared manually and the temperature and humidity were influenced by seasonal variability and the locality of seasoning. The conservation of the peculiarities of the salami and sausages has required the identification and quantification of those properties that better describe the characteristics of these products: the characteristics of the formulations, the type of process, the chemical and microbiological characteristics and the local traditions.

Tecniche di trasformazione delle carni suine di razza autoctona: dalla materia prima al prodotto tradizionale finale

Parole chiave aggiuntive

Salami salsicce.
Caratteristiche chimiche e microbiologiche.
Suino Nero Siciliano.
Suino razza Sarda.

SOMMARIO

Nell'Europa Mediterranea, Italia in particolare, vi è una consolidata tradizione di prodotti stagionati preparati con carne suina. I prodotti ottenuti da carni di suini autoctoni e descritti come tipici sono spesso legati ad antiche tradizioni locali e la tecnica di elaborazione / preparazione utilizzata può influenzare le proprietà finali. Durante l'indagine sono state analizzati campioni di salami e salsicce ottenuti da suini di razza *Nero Siciliano* e da suini di razza *Sarda*. La preparazione di salami e salsicce è stata condotta presso alcuni laboratori artigianali situati nella zona tradizionale della Sicilia *(Nebrodi)* e della Sardegna, secondo le tecniche in uso nelle tradizioni rurali. Le miscele sono state preparate manualmente e la temperatura e l'umidità sono state influenzate dalla variabilità stagionale e dalla località di stagionatura. La conservazione delle peculiarità del salame e delle salsicce ha richiesto l'identificazione e la quantificazione di quelle proprietà che descrivono al meglio le caratteristiche di questi prodotti: tipologia delle formulazioni, tecnica di preparazione/maturazione, caratteristiche chimiche e microbiologiche dei prodotti stagionati.

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INTRODUCTION

Traditional cured meat products are foods consumed regionally or locally for an extensive time period and reflect cultural heritage and are expression of culture, history and life-style (Leroy et al. 2014). In Sicily, on the *Nebrodi* mountains, characterized by extensive and rich forests, is raised almost all of *Nero Siciliano* pig subjects whose meat is used for fresh consumption or for the preparation of Nebrodi *salumi*. The subjects of *Nero Nebrodi* pig, thanks to the high rusticity are left free to graze and only in the presence of deficient pasture, the integration with natural food products is used.

In analogy to other indigenous pigs, like *Cinta Senese* and *Sarda*, are characterized by slow growth, a modest yield of lean cuts and a marked adiposity (Pugliese et al. 2003). The *Sarda* breed pigs, and/or its crossbreeds, are reared with an extensive system in marginal and inland areas of Sardinia where the archaic traditions in breeding and transformation of meats have been maintained alive (Porcu et al. 2007). The final characteristics of salami are influenced by raw material, by aging conditions and by microbiota (Baldini et al. 2000). The *Nebrodi* salami and *Sarda* sausage present a craft tied to family traditions; the largest differences are found in doses of ingredients (salt, pepper, aromatic spices) added to the mixtures of native pork meat (Moretti et al. 2004). With this analysis, the physical-chemical and microbiological properties of salami and sausages produced in the Nebrodi mountains (Sicily) and in the different area of Sardinia were studied.

MATERIAL AND METHODS

Sampling *Nebrodi* salami

Salami mixtures prepared at six farms located in the Nebrodi area and identified by the letters A, B, C, D, E and F were analyzed. The mixtures were prepared using lean meat of *Nero Nebrodi* pigs and a "taglialardelli" tool reproducing the "pieces of meat" traditionally obtained with the cut to "knife tip". The fresh mixtures were added with sea salt (from 28 to 33 g / kg), black pepper (2-4 g / kg), sucrose (150 g / kg), potassium nitrate (0.025 g / kg), spices and natural flavors optional. The salami were analyzed at 90 days of ripening.

Sampling *Sarda* sausages

Five batches of sausages were produced according to traditional methods by five different artisan producers, identified by the letters AA, AB, AC, AD, AE and located in different areas of Sardinia. The fresh mixtures prepared using all cuts of *Sarda* crossbreed pigs were added with sea salt (from 20 to 33 g/kg), black pepper (1-4 g/kg), spices and natural flavors optional. The sausages were analyzed at 28 days for producer AD, at 35 days for AE and at 40 days for producers AA, AB, AC.

Physical-chemical analyses

The salami samples were prepared by depriving of the casing and grinded with a laboratory knife mill, type GRINDOMIX GM 200, for about 1 minute at a speed of 6,000 -7,000 r / min. pH measurement was performed on the grinded sample with digital pH meter CRISON micro pH 2001. The water activity (a_w) was measured potentiometrically, with Aqualab appliance, on the triturated sample. Only for *Nebrodi* salami the moisture, fat and sodium chloride were determined according to AOAC methods (AOAC, 1995).

Microbiological analysis

The samples for microbiological analysis, after disinfection with alcohol + Iosan and subsequent flaming, were sliced with sterile tools, introduced into a sterile envelope and homogenized with sterile saline in the ratio 1: 3 with the Stomacher for 30 seconds. Tryptone soya agar (Oxoid) at 30 ° C for 72 hours for total microbial count; Mannitol salt agar (Oxoid) at 37 ° C for 72 hours for Micrococci and Staphylococci non-pathogenic; Kanamycin Esculin Azide agar (Oxoid) at 44 ° C for 24 hours for Enterococci, typical colonies were tested with antiserum group D of the Streptococcal Grouping Kit (Oxoid); Violet red bile glucose agar (Oxoid) at 37 ° C for 24 hours to Enterobacteria; MRS agar (Oxoid) at 30 ° C for 72 hours for lactic acid bacteria; Malt extract agar (Oxoid) at 25 ° C for 72-96 hours for yeast and moulds .

RESULTS AND DISCUSSION

Physical-chemical analyses *Nebrodi* salami

The physical-chemical analytical data of the fresh mixtures show that the moisture content is between 55 and 65%, the amount of fat between 11 and 26%; both parameters reflect the type of the employed cuts, mainly shoulder and ham. As regards the final characteristics, the values of moisture and fat are comprised respectively between 25 and 42% and 22 and 40% depending on the ripening conditions and manufacturer. The final pH varied between 5.3 and 6.1. The pH values detected indicate a weak acidification as found in other Italian traditional salami (Diaferia et al. 2000; Baldini et al. 2000; Aquilani et al. 2007).

The a_w of the mixture decreases from the initial value equal to 0.96 to the final value between 0.81 and 0.91. The final amount of salt is between 5% and 6%, according to the different initial amount and the different ripening technique. The values are similar to those

Table I. Values maximum and minimum of microbiological analysis of *Nebrodi* salami and *Sarda* sausages - different farms, end of aging (Valori massimi e minimi dell'analisi microbiologica dei salami dei Nebrodi e della salsiccia Sarda – differenti aziende, fine stagionatura).

	Nebrodi salami		*Sarda* sausages	
cfu/g	Max	Min	Max	Min
Aerobic plate count	1.2E+09	4.8E+07	5.0E+08	2.0E+04
Enterobacteria	1.5E+03	Absent	5.8E+03	Absent
Staphylococci	1.8E+07	2.4E+03	2.5E+07	1.2E+04
Enterococci	9.9E+04	2.1E+02	4.8E+03	<10
Lactic Acid Bacteria	1.5E+09	7.5E+07	4.6E+08	3.0E+07
Yeast and Moulds	3.0E+03	< 30	2.3E+07	3.0E+02

found in other typical naturally dry salami of Mediterranean regions and are fundamental for keeping low acid products (Aquilanti et al. 2007; Gounadaki et al. 2008).

Physical-chemical analyses *Sarda* sausage

The pH did not widely vary during ripening. All batches reached the minimum pH value on the 14th day of ripening and the pH never reached values below 5.3. The final pH was 6.2 after 28 days of aging and the high pH values detected may be due either to the fact that no fermentable sugars were added to the meat or to a limited acidifying activity of the indigenous microbiota. At the start of ripening aw was almost the same (0.96/0.97) in all batches and decreased during ripening and ranging from 0.81 to 0.89 at the end of aging. For example, the value of about 0.88 was detected on the 28th, 35th, 40th day of ripening in batch AB, AE, AA respectively. The lowest value was observed in batch AD after 28 days of ripening. The values are similar to those found in other traditional salumi (Aquilanti et al. 2007; Gounadaki et al. 2008).

MICROBIOLOGICAL ANALYSIS AND CHARACTERIZATION OF MICROBIAL POPULATION IN NEBRODI SALAMI

The mixtures showed low levels of Enterobacteria that were absent or 10^3 cfu/g at the end of aging; lactic acid bacteria and staphilococci, typical microorganism of salami, showed a high initial concentration, 10^5 -10^7 cfu/g and 10^4 – 10^6 respectively; at the end of aging (90 days) lactic acid bacteria increased and staphylococci showed a weak growth; at the end of ripening the number was close to that found in other traditional dry meat product (Moretti et al. 2004, Aquilanti et al. 2007). The moulds and yeasts achieve a final charge between 30 and 10^3 cfu/g; Enterococci, considered important for ripening and for flavor development of traditional salami and sausages (Franz et al. 2003) ranged from 10^2 to 10^4 cfu/g **(Table I)**.

In the meat mixtures *Staphylococcus xylosus* represents 48-62% of the microflora coccica found. Singular in the early stages, the relevance of *S. equorum* with a variable presence 21-34% represented in all samples before the drying process. *S. saprophyticus* is present in all the samples tested, while occasional was the presence of *S. epidermidis*. In the early stages, all species are characterized by a differentiated presence of biotypes, as is shown in **Table II**. However, in all salami from different producers, already at the start of drying it requires the presence of *S. xylosus* that quickly becomes predominant representing almost the totality of the isolable strains in the mature product. As regards the lactic acid bacteria is highlighted the settlement and the subsequent evolution, even in the presence of a clear numerical variability in the different samples examined. In this first phase the *Lactobacillus sakei* is the majority type with values around 60% of the lactic acid bacteria isolated followed by *L. curvatus* which covers about 18% as well as *L. plantarum* that also shows a similar percentage of the presence of around 15%. Also here we can observe a considerable differentiation of biotypes in all species represented as shown in **Table III**. In the course of maturation, as detected by the microflora staphylococcal specific, it is observed a pronounced prevalence from 1 to 3 biotypes for *L. sakei*, from 1 to 2 for both *L. curvatus* that for *L. plantarum*, considered in reference to the different producers. In all the aging samples the biotype of *L. sakei* prevails over that of *L. curvatus* with a coverage percentage that ranges from a maximum of 85% to a minimum of 70%, the presence of L. *curvatus* biotypes is complementary.

Microbiological analysis and characterization of microbial population in *Sarda* sausage

The initial lactic acid bacteria level ranged from 10 to 10^4 cfu/g, their number rapidly increased and reached high level at the end of aging in the order of 10^7/10^8 cfu/g as found in other Mediterranean dry sausages (Comi et al. 2005; Urso et al. 2006). The initial number of staphylococci varied from 10^4 – 10^5 cfu/g and the trend was different in the five producers; the level of Enterococci was in the order of 10^2 cfu/g and at the end of aging ranged from 10 to 10^3 cfu/g; the initial number of moulds and yeasts was in the order of 10^2 cfu/g and their counts increased during ripening, similar values were detected in several traditional Medite-

Table II. Species and biotypes of Staphylococci isolated from salami product in the area of the *Nebrodi (*Specie e biotipi di Stafilococchi isolati da salami prodotti nell'area dei Nebrodi).

Processing phases	Strains isolated	*St. xylosus* biotypes %		*St. equorum* biotypes %		*St. saprophyticus* biotypes %		*St. epidermidis* biotypes %	
Filling	123	32	48-62	18	21-34	11	3-4	9	0-5
End aging	136	7	97-100	0	n.d.	0	n.d.	0	n.d.

St = *Staphilococcus* , n.d.=not determined.

Table III. Species and biotypes of Lactic acid bacteria isolated from salami product in the N*ebrodi* area (Specie e biotipi di batteri lattici isolati da salami prodotti nell'area dei Nebrodi).

Processing phases	Strains isolated	*Lactobacillus sakei* biotypes %		*Lactobacillus curvatus* biotypes %		*Lactobacillus plantarum* biotypes %	
Filling	68	19	58-60	12	18-20	14	15-20
End aging	72	3	70-85	1-2	15-30	0	n.d.

Table IV. Species and biotypes of Lactic acid bacteria isolated from sausages product in the different area of Sardinia (Specie e biotipi di batteri lattici isolati da salsicce prodotte in differenti aree della Sardegna)

Species	*Lactobacillus sakei*	*Lactobacillus curvatus*	*Leuconostoc mesenteroides*	*Leuconostoc citreum*
N° isolates	182	40	6	14
N° biotypes	104	33	4	7
% isolates	74.3	16.3	<1	<1

rranean dry sausages (Aquilanti et al. 2007; Gounadaki et al. 2008); the Enterobacteria progressively decreased during ripening **(Table I)** .

A total of 245 colonies from MRS and 250 colonies from MSA were isolated. As regards isolates from MRS, 74.3% of them were identified as *L. sakei*; the second main species isolated was *L. curvatus* (16.3%), they were isolated at all stage of ripening (table IV); other species isolated, in line with the assertions of Comi et al. (2005) and Urso et al. (2006), were *Leuconostoc citreum*, *Leuconostoc mesenteroides*, *L. paracasei*, *L. brevis*, *Weissella spp*. Among CNS (Coagulase Negative Staphylococci) from MSA, *S. xylosus and S. equorum* were the most frequently isolated species and were present throughout all the ripening period. *S. equorum,* isolated also in *Nebrodi* salami and other Italian traditional dry sausages (Mauriello et al. 2004), was present at all stages of ripening and was detected in almost all producers except AA. *S. saprophyticus* was isolated only from one producer at the end of ripening (28 days). *S. pulvereri* was isolated only in producer AC at all stages of ripening, while *S. warneri* was isolated only in producer AB. The species *S. epidermidis*, *S. pasteuri* and *S. warneri* were detected only at the start of ripening. *S. succinus* was detected in two producers. The highest number of species was found in producer AB (6 species).

In conclusion, the different samples of *Nebrodi* salami and *Sarda* sausage show the prevalence of specific microflora represented by the lactic acid bacteria and staphylococci. The microflora of the production area is then characterized by a rich biodiversity which is evident in a surprising large distribution of species represented in a diverse range of biotypes, both in reference to the lactic acid bacteria to specific staphylococci. Furthermore, the variability of physical-chemical values is related to the different producers and to the diversity of environments and aging conditions. The results highlight the importance of traditional products valorization as an important means to preserve biodiversity, and that the selection of native strains can help to add value to traditional products.

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BIBLIOGRAPHY

AOAC 1995, 'Official methods of Analysis', Association of Official Analitical Chemists, Sixteenth Edition.

Aquilanti, L, Santarelli, S, Silvestri, G, Osimani, A, Petruzzelli, A & Clementi, F 2007, 'The microbial ecology of a typical Italian salami during its natural fermentation', *International Journal of Food Microbiology*, vol.120, pp. 136-45.

Baldini, P, Cantoni, E, Colla, F, Diaferia, C, Gabba, L, Spotti, E, Marchelli, R, Dossena, A, Virgili, E, Sforza, S, Tenca, P, Mangia, A, Jordano, R, Medina, L & Solignat, G 2000, 'Dry sausages ripening: influence of thermohygrometric conditions on microbiological, chemical and physico-chemical characteristics', *Food Research International*, vol. 33, pp. 161-70.

Comi, G, Urso, R, Iacumin, L, Rantsiou, K, Cattaneo, P, Cantoni, C & Cocolin, L 2005, 'Characterisation of naturally fermented sausages produced in the North East of Italy', *Meat Science*, vol. 69, pp. 381-92.

Diaferia, C, La Pietra, L, Longo, M, Magliano, V & Pirone, G 2000, 'Napoli Type salami processing from various indigenous genetic lines of pig. III. Chemical physical and microbiological characteristics', *Options Mediterranéennes*, vol.41, pp. 241-44.

Franz, CMAP, Stiles, ME, Schleifer, KH & Holzapfel, WH 2003, 'Enterococci in foods a conundrum for food safety', *International Journal of Food Microbiology*, vol. 88, pp.105-22.

Gounadaki, AS, Skandamis, PN, Drosinos, EH & Nychas, G-JE 2008, 'Microbial ecology of food contact surfaces and products of small-scale facilities producing traditional sausages', *Food Microbiology*, vol.25, pp. 313-23.

Leroy, F, Scholliers, P & Amilien, V 2014, Elements of innovation and tradition in meat fermentation: Conflicts and synergies', *International Journal of Food Microbiology*, vol. 212, pp. 2-8.

Mauriello, G, Casaburi, A, Blaiotta, G & Villani, F 2004, 'Isolation and technological properties of coagulase negative staphylococci from fermented sausages of Southern Italy', *Meat Science*, vol. 67, pp. 149-58.

Moretti, VM, Madonia, G, Diaferia, C, Mentasti, T, Paleari, MA, Panseri, S, Pirone, G & Gandini, G 2004, 'Chemical and microbiological parameters and sensory attributes of a typical Sicilian salami ripened in different conditions', *Meat Science,* vol. 66, pp. 845-54.

Pugliese, C, Madonia, G, Chiofalo, V, Margiotta, S, Acciaiolo, A & Gandini, G 2003, 'Comparison of the performances of Nero Siciliano pigs reared indoors and outdoors. 1. Growth and carcass composition', *Meat Science*, vol. 65, pp. 825-31.

Porcu, S, Usai, G, Carta, A & Ligios, S 2007, 'L'élevage du porc en Sardaigne entre histoire et actualité' *Options Méditerranéennes*, vol.76, pp. 137-42.

Urso, R, Comi, G & Cocolin, L 2006, 'Ecology of lactic acid bacteria in Italian fermented sausages: isolation, identification and molecular characterization', *Systematic and Applied Microbiology*, vol.29, pp. 671-80.