CHARACTERISATION OF MEDITERRANEAN AND NORTH EUROPE FERMENTED MEAT PRODUCTS: CHEMISTRY AND OXIDATIVE STABILITY ASPECTS

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Background

Fermented meat products (FMP) occupy an important share of meat consumed in many parts of the world. Preservation by fermentation of salted and minced meat has been empirically applied and developed over the centuries but only during the last few decades it has been the object of scientific investigations. There are two main types of FMPs in Europe: 1) a Mediterranean or southern type, generally characterised by slow pH fall, pH of matured products higher than 5, flavour substantially affected by the use of spices and long maturing times; 2) a northern type characterised by fast pH fall, final pH lower than 5, smoking and shorter maturing times.

Objectives

The research was aimed at collecting data on the differences existing between the two types of FMPs as a preliminary step for a subsequent work of technological improvement and standardisation. The data reported here are of a chemical type dealing mainly with lipids and oxidative processes to prepare the ground for deeper investigations on lipid oxidation and degradation as related with flavour development and the possible production of toxic molecules.

Methods

Two Mediterranean (*M1* and *M2*) and two northern type (*N1* and *N2*) fermented meat products have been processed by local European manufacturers. Five batches of each type have been produced with the following formulations.

Mediterranean type sausage M1. Fresh pork shoulders (72%) and pork streaky bacon (28%) were minced to 3.5mm particle size and mixed with salt (2.5%), skimmed milk (2.8%), $NaNO_2$ (80ppm), KNO_3 (120ppm), sucrose (0.5%), dextrose (0.3%), ascorbic acid (0.03%), black pepper (0.07%), white pepper (0.03%), garlic (0.01%). A commercial mixture of *L. curvatus* and *M. varians* was used as starter culture. Total processing lasted 40 days.

Mediterranean type sausage M2. Fresh (33%) and frozen (33%) lean pork cuts and pork back fat (33%) were minced to 2.5mm particle size and mixed with salt (3%), caseinate (1.15%), $NaNO_2$ (180ppm), dextrose (0.5%), sodium ascorbate (0.09%) and black pepper (0.07%). A mixture of *L.sake*, *P.pentosaceus*, *St. xylosus* and *M.varians* was used as starter culture. Total processing time was 28 days.

Northern type sausage N1. Frozen beef (33%), fresh pork (33%) and pork back fat (33%) were minced to 2.5mm particle size and mixed with salt (3%), caseinate (1.15%), $NaNO_2$ (180ppm), dextrose (0.7%), sodium ascorbate (0.09%), black pepper (0.07%). A mixture of *L.sake*, *P.pentosaceus*, *St. xylosus*, *St. carnosus* and *M.varians* was used as starter culture. The sausages were smoked for 1 hour and total processing time took 14 days.

Northern type sausage N2. Frozen and fresh beef (30%), frozen pork (40%) and pork back fat (30%) were minced to 2.0mm particle size and mixed with salt (4%), $NaNO_2$ (240 ppm), dextrose (0.43%), a mixture of oleoresins (garlic, coriander, paprika) and cognac. A mixture of *Lactobacillus* and *St. carnosus* was used as starter culture. The sausages were smoked for 2.5 hours and total processing time was 21 days.

Mature sausages were characterised for proximate composition, NaCl, pH, non protein nitrogen (N.P.N.), residual nitrites and nitrates, vitamin E, fatty acid composition of total fat, TBARS (Novelli et al., 1998), total cholesterol, cholesterol oxides (Zanardi et al., 1998) and volatiles aldehydes (Reindl and Stan (1982) modified according Eerola S, Hartikainen K. and Rizzo A.. (Report 1999, FAIR-CT97-3227)). The sausages were also sliced, packed under vacuum and exposed to fluorescent light in a display cabinet for 45 days, 12 hours a day. The samples so prepared were sensory evaluated for colour stability three times a week by a panel of 8 members (Ghiretti et al., 1997) and used, at the end of the trial, for the determination of TBARS and cholesterol oxides.

Results and discussion

The 4 FMPs differed for some basic chemical aspects. Namely, *M1* was characterised by 52% fat and 39% protein on dry matter whereas *M2*, *N1* and *N2* had similar fat (around 60-61 %) and protein (around 30-31%) contents on dry matter. Moisture content varied from around 38-39% in *M1* and *N2* to 33% of *M2* and 43-44% of *N1*. The two Mediterranean FMPs had pH values between 5.4 and 5.6 whereas pH values of northern type FMPs were between 4.6 and 4.8. Non protein nitrogen was similar in *M1* and *N2* (about 14%), lower in *N1* (about 12%) and very low in *M2* (about 7%). Residual nitrates and nitrites were barely detectable in all FMPS. Vitamin E content, on a dry weight basis, was around 5.6-6.3ppm in *M1*, *M2* and *N1* but only about 2.3ppm in *N2* sausages (Table 1). The relatively high content of saturated fatty acids (43%) and the relatively low content of polyunsaturated fatty acids (11%) in *N2* sausages appeared to be a clear consequence of the use of beef (Table 1). The same consideration, though, did not apply to *N1* sausages (also containing beef) that showed a fatty acid composition very similar to the one observed in *M2* sausages. The latter had the highest content of polyunsaturated fatty acids. Total cholestesterol content was significantly higher in *M1* sausages (Table 1), probably a consequence of different raw materials, for instance the streaky bacon.

Average values of TBARS determination (Table 2) have posed *M1* sausages at the highest level, followed by *N2*, *M2* and finally *N1*. Absolute values, though, were in all cases lower than 0.5 and therefore inside acceptable quality standards. Moreover, variability was rather high with C.V. higher than 30% in *M1*, *M2* and *N2* and around 20% in *N1* and, indeed, only *M1* was significantly different from the others. Exposure to fluorescent light had the effect of significantly increasing TBARS values in all sausage types by a factor of least 2. The biggest relative increase was observed in *N2* sausages in which TBARS increased about 15 times. The reason for such a difference, compared with the other three sausage types, could be tentatively attributed to the lack of sodium ascorbate or ascorbic

acid in the formulation.
The data of cholesterol oxides (Table 3) did not show any clear pattern among the four different sausage types, nor did it appear after 45 days exposure to fluorescent light. The percentage of oxidised cholesterol was around 0.1% of total cholesterol, a value in line with previous investigations. The measurement of volatile aldehydes (Table 4) clearly marked the difference between Mediterranean and northern sausages: total aldehydes content was higher by at least a factor of 10 in Mediterranean sausages compared with northern types. The pattern, though, did not recall TBARS data and for most compounds variability was very high. In all FMP types the most important molecule was hexanal with a minimum value of 160ppb in *N1*, followed by 330ppb in *N2*, up to 8000ppb in *M1* and 12000ppb in *M2*. The hexanal content, therefore, did not match TBARS values, at least in Mediterranean sausages.
Colour stability appeared to be higher in Mediterranean sausages compared with North Europe ones. *N2* sausages, in particular, in less than 10 days reached an average score of 3 considered a non-acceptability threshold. The lower colour stability of North of Europe sausages could be due to various causes: the lower pH with its effect on the co-ordination state of nitrosylmyoglobin (Morita et al., 1999), the use of beef, a meat type richer in myoglobin which could appear darker to the panel and, for *N2* sausages, the lack of sodium ascorbate in the formulation.

Pertinent Literature

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TABLE 1. Vitamin E (ppm/dry weight), total fatty acid composition (%) and cholesterol (mg/100g dry weight).

Sausage type	Vitamin E	Saturated	Monounsaturated	Polyunsaturated	Cholesterol
M1	5.73±0.90^{a}	39.63±0.53^{a}	46.87±0.57^{c}	13.50±0.68^{ab}	150.0±3.8
M2	5.57±1.08^{a}	39.16±1.15^{a}	44.50±1.07^{a}	16.34±1.97^{b}	123.9±4.7
N1	6.28±1.90^{a}	39.40±1.11^{a}	45.13±1.05^{ab}	15.47±2.09^{b}	125.7±3.4
N2	2.28±0.90^{b}	43.21±0.54^{b}	45.66±0.31^{abc}	11.12±0.67^{a}	121.7±3.1

TABLE 2. TBARS values (mgMDA/kg) before and after exposure to fluorescent light

Sausage type	0 days of exposition	45 days of exposition
M1	0.333±0.120^{b}	0.846±0.251^{b}
M2	0.106±0.033^{a}	0.190±0.060^{a}
N1	0.077±0.017^{a}	0.152±0.037^{a}
N2	0.154±0.052^{a}	2.382±0.540^{c}

TABLE 3. Cholesterol oxidation products (COPs) (ppm/fresh weight) of sausages before and after exposure to fluorescent light

Sausage type	Days of exposure	7β-hydroxychol.	5,6α-epoxidechol	7-ketocholest.	Total COPs	%oxidised chol.
M1	0	0.11±0.06	0.13±0.05	0.28±0.18	0.52±0.25	0.06±0.03
	45	0.45±0.27	0.08±0.02	0.65±0.09	1.18±0.36	0.13±0.04
M2	0	0.05±0.03	0.56±0.04	0.12±0.06	0.74±0.12	0.09±0.01
	45	0.07±0.03	0.39±0.08	0.08±0.02	0.54±0.07	0.07±0.01
N1	0	0.07±0.03	0.77±0.07	0.11±0.05	0.95±0.12	0.13±0.02
	45	0.06±0.03	0.40±0.14	0.09±0.08	0.55±0.17	0.08±0.02
N2	0	0.14±0.03	0.23±0.05	0.06±0.02	0.42±0.08	0.06±0.01
	45	0.12±0.06	0.41±0.07	0.15±0.04	0.68±0.07	0.09±0.01

TABLE 4. Aldehydes content (ppb/fresh weight) of matured sausages

Sausage type	Butanal	Hexanal	Heptanal	2-octenal	Octanal	2-nonenal	2,4-decadien	Nonanal	Decanal	Total aldehydes
M1	110±27	8000±1200	160±17	110±24	230±20	250±40	220±50	550±71	120±21	9706±1263
M2	230±50	12000±5200	360±100	170±70	390±110	120±41	72±18	460±150	69±26	14326±5682
N1	79±4	160±87	17±12	25*	34±22	42*	62*	130±97	140±52	562±277
N2	31±9	330±270	25±13	39±25	39±23	61±45	99	128±109	77±27	663±514

*only one sample