RESULTS OF PHYSICOCHEMICAL AND SENSORIAL INVESTIGATION OF DIFFERENT TYPE OF FERMENTED SAUSAGES DURING FERMENTATION AND RIPENING PROCESS

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Background

The production of naturally fermented sausages in the Mediterranean countries and the southern part of Central Europe has a very long tradition. In the second half of the 20th century, sausage production has been gradually industrialized and a very large assortment of fermented sausages has been developed. Aiming at maintaining the traditional sensorial quality of dry sausages and to assure their safety, although produced in industrial scale, it is important to develop and use protective cultures, after selection of strains isolated from naturally fermented products. A prerequisite for this research is to identify the main differences in the traditional production of fermented sausages, in various countries, and to study the evolution of physicochemical and sensorial characteristics of the sausages, during natural fermentation and ripening.

Key words: fermented sausages, physicochemical features, sensorial characteristics

Objectives

The main task of the research was to investigate the physicochemical features (pH, a_w and NaCl content) and the sensory characteristics of certain naturally fermented sausages, as produced traditionally in different countries (Greece, Serbia and Montenegro, Bosnia and Herzegovina, Croatia, Hungary and Italy). At the beginning, sausage composition was defined and then, during the processes of fermentation and ripening, the physicochemical and sensorial characteristics were investigated.

Materials and methods

For the purpose of the investigations, typical traditional sausages were produced in local meat processing plants, without using starter cultures. Sausages composition is presented in the table 1. The specifications applied in the preparation stage (final size of meat and fat pieces and used casings) as well as the critical technological parameters (i.e. temperature, relative humidity and duration) in the subsequent stages of traditional production (i.e. draining of stuffed sausages, smoking, fermentation, ripening and drying), are presented in table 2.

Three batches of sausages were used for the experiments, carried out within a 3 month period. Samples were taken from each batch at 0, 2, 4, 7, 14 and 28 days after formulation. Every sampling day, 3 sausages were transported to the laboratories and subjected to physicochemical analysis (moisture, NaCl, nitrite and nitrate content, pH and a_w). Standard methods were used for the analysis.

At the end of each process, sausage samples were subjected to sensory analysis. A panel of 10 persons was created in each country. In a 10 degrees scale, the panelists had to grade the produced sausages for coherence, smell, acidity, tenderness, flavor, after taste and overall impression. The differences in the sensory scores were further evaluated using a statistical program.

Results and discussion

Sausage composition, dimensions as well as fermentation-ripening processes varied among the different countries. Serbian, Hungarian and Italian sausages are produced by pork meat, only. The Bosnian sausages are produced by beef meat only, while the Croatian and Greek producers use mixed pork and beef meat. Other ingredients are sugars, salt, fat and spices (it might be simply black pepper for Italian sausages, garlic and paprika for Serbian sausages or spice mixture). The size of sausages varied between 28 and 50 mm in

diameter. Smoking was applied for the sausages produced in Serbia, Bosnia and Croatia, partial smoking in Hungary and Greece, while in Italy no smoking was performed. Ripening of the sausages was carried out under controlled conditions of temperature and relative humidity. In general, temperature higher than 12°C and relative humidity 60-80%, were the conditions of ripening in all countries, except for Serbia where ripening temperature was at 5-12°C. Sausages were considered ready for consumption on the 28th day, which was also considered the final time point of experiments. It should be noted that for the Croatian sausages, ripening times were usually shorter, but for purposes of harmonization with the rest of the partners, experiments were carried out beyond the average time of release to the market.

In sausages examined in Greece the most intensive decrease of pH (table 3) was observed during the fermentation and ripening procedure (6.25 to 4.90). The lowest starting pH (5.47) was detected in sausages produced in Serbia and Montenegro, but its decrease during processing was very slow (final pH was 5.27). In sausages produced by beef meat (Bosnia and Herzegovina), decreasing of pH had the most correct flow (from 6.15 to 4.86). The Croatian, Bosnian and Italian sausages showed a pH decrease till 7th day, and a slow increase in the rest 21 days of production. In sausages investigated in Hungary pH changes had the similar flow, but at a little higher level than the sausages from Serbia and Montenegro. Generally, final pH values were between 4.86 and 5.66. The most acid sausages were produced in Bosnia and Herzegovina (4.86) and Greece (4.90) and the most basic in Italy (5.66).

Salt content (table 4), just after the preparation (day 0), was between 1.51% (Croatia) and 2.52% (Italy). Proportionally to starting content and degree of moisture losses, an increase of NaCl content was observed. At the final product, the highest concentration of salt was determined in Hungarian sausages (4.71%).

Significant differences were observed in a_w values (table 5). After 28 days, a_w values in sausages investigated in Bosnia and Herzegovina, Croatia and Italy were higher than 0.90, while the lowest a_w values in the final product were found in sausages prepared in Greece, Serbia and Montenegro.

Sensorial characteristics of sausages (Figure 1), processed in the traditional way, were evaluated very high (overall impression was above 70), except products examined in Croatia. Differences between investigated sausages in other countries and Croatia were probably due to the prolongation of the usual process. Sensorial characteristics of sausages, in all 6 countries, showed that they were of very high quality with characteristic smell, flavor and coherence.

Conclusions

There are differences among the produced fermented sausages in the 6 countries, as far as composition, size and fermentation-ripening process. Physicochemical changes that occurred during ripening, can be summarized as follows for all countries:

1. Decrease of pH (final value between 4.86 and 5.66; sausages produced in Bosnia, Herzegovina and Greece are the most acid, and in Italy the most basic);
2. Decrease of a_w (final values between 0.78 and 0.94; Greek sausages had significantly lower a_w compared with the ones from other countries);
3. Increase of NaCl content (final values between 2.29 in Croatian sausages and 4.71 in the Hungarian ones).
4. The sensory analysis of the final products showed an overall acceptability of the products, above 70% for all partners, except for Croatia, due to the extension of the regular ripening time.

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Sausage composition

Table 1

Ingredients	Composition (%)					
	Greece	SM	BH	Croatia	Hungary	Italy
Pork meat	35	70	-	62	63.5	60
Beef meat	35	-	96[4]	10	-	-
Pork back fat	30	30	-	25	32.5	40
Salt	2.5	2.6	2.5	2.5	2.3	2.5
Sugars	1.5[1]	0.5[3]	0.3[5]	0.3	0.1[1]	1.5
Skim milk pow.	2.5	-	-	-	-	-
Spices	0.3[2]	-	-	3.0[6]	1,5[2]	-
Garlic	0.1	0.8	1.0	-	0.4	-
White wine	0.2	-	-	-	-	-
$NaNO_3$	0.02	-	-	-	-	+[7]
$NaNO_2$	0.02	0.016	0.015	0.013	0.01	0.02[7]
Na-ascorbate	0.06	-	-	-	-	-
Paprika	-	0.6	-	-	-	-
Black pepper	-	-	0.2	-	-	0.07

[1]commercial mixture of maltodextrins with salt, Na-ascorbate, KH_2-phosphate and essential oils;[2]black pepper, red pepper and cloves; [3]dextrose; [4]beef meat with max. 20% of viable fatty tissue from cattle not older than 5 years; [5]commercial mixture of sugars as at [1]without essential oils;[6]black pepper, red pepper and garlic; [7] blend of $NaNO_2$ and $NaNO_3$

Technological parameters in the production of traditional fermented sausages

Table 2

Parameter	Greece	SM	BH	Croatia	Hungary	Italy
Preparing						
-meat pieces (mm)	10	8	10	12	-	-
-final fat size (mm)	2	5	2-3	2	3-5	
-casing	synthetic	natural	synthetic	natural	natural	natural
-diameter (mm)	45	30-32	32	32-34	28	50
Draining						
-temperature (°C)	15-18	environ.	15-18	20	15-18	22
- rel. humidity (%)	-	-	-	95	-	85
-duration	2-3h	1 day	2-3h	12h	2-3h	2 days
Smoking	after 2nd day[1]	Classic[2]				
-temperature (°C)	24	-	15	20	20	
-rel. humidity (%)	-	-	90	85-90	75	
-duration	2-3h	4days	7days[4]	2 days	2h[6]	
Fermentation		Traditional	Traditional	Tradiotional		
- temperature (°C)	24-20	drying and	drying and	drying and	20	12[7]
- rel. humidity (%)	94-86	ripening	ripening	ripeniing	80	60-90
- duration	7 days				2 days	5 days
Ripening						
- temperature (°C)	15-16	5-12[3]	14-18	20-16	15	12
- rel. humidity (%)	80	85-60	90-75	90-75	75	65-85
- duration	21 days	21 days	21 days	26 days[5]	14 days	21 days

[1]smoking performed after 2nd day of fermentation; [2]smoking process in classic smoking chamber without thepossibility for air conditioning with open burning fire; [3]temperature depended of the outdoor temperature; [4]smoking regime was 4h of smoking and 4h pause during 24h; [5]usual duration of drying and ripening is 19 days; [6]after draining sausages were in fermentation chamber 8h at 17°C and 70% RH, prior of smoking; [7]temperature was decreased from 22°C to 12°C with a rate of 2°C per day

Changes of pH during fermentation and ripening of sausages (mean values of three batches)

Table 3

Country	Day					
	0	2	4	7	14	28
Greece	6.25	5.70	5.37	4.91	4.85	4.90
SM	5.47	5.34	5.26	5.15	5.06	5.27
BH	6.15	5.58	5.03	4.81	4.82	4.86
Croatia	6.15	6.00	5.84	5.21	5.23	5.38
Hungary	5.89	5.84	5.79	5.64	5.48	5.53
Italy	5.73	5.54	5.40	5.34	5.50	5.66

Changes of NaCl content (%) during fermentation and ripening of sausages (mean values of three batches)

Table 4

Country	Day					
	0	2	4	7	14	28
Greece	2.39	2.66	3.06	3.30	3.89	4.05
SM	2.42	2.69	2.78	3.09	3.15	3.73
BH	2.36	3.35	3.36	3.40	3.80	4.32
Croatia	1.51	1.54	1.69	2.05	2.22	2.29
Hungary	2.50	2.86	3.44	3.43	3.94	4.71
Italy	2.52	2.66	2.72	2.95	3.11	3.34

Changes in a_w value during fermentation and ripening of sausages (mean values of three batches)

Table 5

Country	Day					
	0	2	4	7	14	28
Greece	0.86	0.85	0.85	0.84	0.83	0.78
SM	0.92	0.92	0.90	0.90	0.87	0.85
BH	0.96	0.94	0.92	0.91	0.90	0.90
Croatia	0.97	0.96	0.96	0.96	0.95	0.94
Hungary	0.96	0.95	0.94	0.94	0.92	0.86
Italy	0.97	0.95	0.93	0.93	0.93	0.92

Sensorial analysis of final product

Figure 1