COMPARISON OF SENSORY AND ANALYTICAL PROPERTIES OF DRY SAUSAGE PRODUCED WITH DIFFERENT PROCESSING PROCEDURES

Kathrin Ulmer and Albert Fischer

University of Hohenheim, Institute of Food Technology, Department of Meat Technology, D-70599 Stuttgart, Germany

Background

Traditional processing of typical German dry sausage followed by ripening in drying chambers takes a long time (up to 20 days), requires huge storeroom capacity, is energy intensive and often results in low production rates. A faster method of producing dry sausage would allow considerable energy savings while raising the production rate. This could have interesting applications in the meat industry.
The concept of adding a certain amount of dried fermented meat in production of dry sausage would not only shorten the ripening time, but also raise the question if there are differences between the final products in terms of organoleptic characteristics such as odor and taste.
In earlier investigations, a number of volatile organic compounds released from dry sausage were analyzed by gas chromatography/mass spectrometry [1, 2, 3, 4]. In dry sausage, identified volatile constituents are mainly derived from added spices (pepper, garlic etc.) and as a result of light and oxygen induced lipid oxidation as well as enzymatical degradation of carbohydrates, proteins and lipids.
Also, sensory properties determined by test panels were reviewed for correlation with more objective and reproducible analytical methods such as GC/MS and electronic nose [5].

Objectives

The objective of this study was to develop a novel method to shorten the ripening time of dry sausage by adding a certain amount of dried fermented meat. In comparison with a traditional German dry sausage product, the overall properties such as odor and taste were determined by sensory evaluation and correlation with GC/MS and electronic nose results have been investigated.

Materials and methods

Production of dried fermented meat: Preparation of meat: Refrigerated lean pork (estimated fat content of 10%) was coarsely cut into pieces. 2.8% nitrite curing salt, 1.2% mixture of spices, 0.3% dextrose and a 0.05% starter cultures compound (containing *L. sakei* + *Staph. carnosus*) (Bitec, Germany) were added. All ingredients were mixed in a blender and minced through an 8 mm plate. Fermentation: The meat was fermented in vacuum-packed bags at 24°C for at least 40 hours depending on the change of the pH value (below pH 5.0). Drying: The meat was air-dried at 50°C. The drying process was completed when the weight was reduced by 60%. The dried fermented meat was chopped again on high speed in the cutter, packed in bags and stored frozen at -18°C.
Production of dry sausage (batch 1, control): Traditional dry sausages were prepared according to the following weight based formula: 30% lean frozen pork (estimated fat content of 10%), 30% 3 mm minced beef (estimated fat content of 8%), 30% frozen pork back fat (estimated fat content of 90%) and 10% 3 mm minced lean pork. Additives and spices were added per kilogram: 28 g nitrite curing salt, 12 g mixture of spices and 0.5 g of a starter cultures compound (containing *L. sakei* + *Staph. carnosus*) (Bitec, Germany). The mass was stuffed into 65 mm diameter fiber-reinforced cellulose casings (Nalo Fibrous, Kalle, Germany).
Production of dry sausage with dried fermented meat (batch 2): Dry sausages were prepared according to the following weight based formula: 5% lean frozen pork, 30% 3 mm minced beef, 30% frozen pork back fat, 10% 3 mm minced pork and 10% dried fermented meat. Additives and spices were added per kilogram (except dried fermented meat): 28 g nitrite curing salt, 12 g mixture of spices, 1 g sodium diphosphate and 0.5 g of a starter cultures compound (containing *L. sakei* + *Staph. carnosus*) (Bitec, Germany). The lack of freezing capacity during chopping makes it necessary to add liquid N_2 periodically. The mass was stuffed into 60 mm diameter fiber-reinforced cellulose casings (Nalo Fibrous, Kalle, Germany).

Ripening: The sausages were placed in a drying chamber under the following conditions: 2 days at 24°C, 88 – 92% relative humidity (RH); 2 days at 20°C, 85 – 88% RH; 3 days at 18°C, 82 – 86% RH and finally the dry sausages were ripened another day (control 8 days) at 14°C, 75 – 85% RH until a weight loss of 25% and another 22 days (control 29 days) at 14°C, 75 – 85% RH until a weight loss of 35% was reached. The sausages were smoked after 2, 3 and 5 days using friction smoke for 30 min each time.
pH measurement: The course of pH while ripening was measured using a spear tip electrode (Schott, Germany). The electrode was calibrated with two buffer solutions of pH 4.000 and 7.000.
Weight loss: The sausages were weighed once a day (Universal pro 32/34 F, Sartorius, Germany) until a weight loss of 25% and 35% was reached.
Sensory evaluation: A sensory panel determined the odor and taste of the dry sausages after a weight loss of 25% and 35% was reached.
Gas chromatography/mass spectrometry: In a 500 ml gas tight glass jar, 50 g of homogenized sample was equilibrated for 30 min at 42°C in a water bath. Then, each sample was purged for 15 min with 200 ml 99,995% pure N_2/min using an automatic sampling device (GS 301, Desaga, Germany). The extracted volatiles were trapped onto 225 mg of Carbotrap 349 (Perkin-Elmer, Germany) in a stainless steel thermodesorption tube. Each sample was analyzed in triplicates. The Carbotrap tubes were thermally desorbed at 300°C in a thermal desorber (ATD 400, Perkin-Elmer, Germany). The compounds were separated in a gas chromatograph (GC 6890, Agilent, Germany) equipped with a DB-5 low polar column and identified using a mass spectrometer (MSD 5973, Agilent, Germany). The temperature was programmed at 40°C for 3 min, from 40°C to 230°C at 7°C/min and to 260°C at 12°C/min and then held at 260°C for 15 min. The mass spectra were recorded in electronic impact mode at 70 eV, from 30 to 250 m/z. Identification of compounds was based on mass spectra from a library database (NBS 75K, Agilent, Germany).
Electronic nose: In a 22 ml headspace vial sealed with a silicon/PTFE septum, 10 g of homogenized sample was equilibrated for 30 min at 50°C in a headspace autosampler (HSS 7694, Agilent, Germany). Each sample was analyzed four times. An aliquot of 3 ml headspace was transferred with the carrier gas to a chemical sensor system based on 4 different metal oxide semiconductor (MOS) gas sensors (VOCmeter-Hybrid, AppliedSensor, Germany). The evaluation by means of a principal component analysis (PCA) was performed using a commercial software package (Argus, AppliedSensor, Germany).

Results and discussion

In the following, different characteristics such as weight loss and pH value between the batches were investigated. A fundamental advantage of batch 2 is the shortening of ripening time. Figure 1 shows the weight loss during ripening. In comparison with the control, the batch with dried fermented meat reaches a weight loss of 25% and 35% after 8 and 30 days, respectively, whereas the control loses the corresponding weights not before 15 and 44 days, respectively. As can be seen, batch 2 already has a 15% weight loss at the beginning of the ripening process. This can be explained by the fact that moisture has been removed from the fermented meat during drying.
After adding the starter cultures to the meat mixture a course in the pH value over the ripening period was obtained (Figure 2). In comparison, the traditional product and the new technology started at different pH values but met after 2 days. The traditional product began at a higher pH level with a steeper decrease within the first day. The batch produced with dried fermented meat started at pH 5.7 and decreased more slowly the first day. This can be explained by the fact that the water activity of this batch was lower than the traditional one and for this reason the starter cultures needed a longer period to grow and to produce lactic acid.
The determination of the odor after a weight loss of 25% and 35% by a sensory panel resulted in no difference at all between the two batches. On the contrary, the taste differed clearly. Batch 1 showed a typical distinct fermented flavor which has been developed during the longer ripening time.
The headspace GC/MS analyses of batch 1 and 2 at the beginning of the ripening process, at 25% and 35% of weight loss are thought to result from a combination of added spices, oxidation processes and microbial activities. Figure 3 represents a typical headspace gas chromatogram of a dry sausage sample. The individual compounds identified by mass spectrometry are shown in Table 1. Between the batches there were hardly any qualitative but more quantitative differences regarding individual volatile compounds. Regarding the hexanal values, both batches show an increase over ripening time (Figure 4), where batch 2 starts at a comparatively high value which might be induced by adding dried fermented meat.
Figure 5 presents a PCA plot of batch 1 and 2 at different ripening stages resulting from electronic nose measurements. Here, all volatile compounds present in the headspace are measured as a sum parameter using

4 MOS sensors with different selectivities to give a specific aroma fingerprint for each individual sample. It can be seen that there is a clear difference between the samples at the beginning and at the end of the ripening time, but hardly any differences between the ripened samples or individual batches. This is in correlation with the odor results obtained by the sensory panel.

Conclusions

The aim of this study was to show that the use of dried fermented meat in the production of dry sausage can shorten the ripening time by about one week. However, this new processing procedure leads to a less intense dry sausage taste. Furthermore, the investigations have shown that analytical tools such as headspace GC/MS and electronic nose can be used to provide more objective and reproducible results, but with the limitation that only the human being can specifically describe taste and odor impressions.

References

[1] Berger, R.G., C. Macku, J.B. German et al. (1990) Journal of Food Science 55 (5), 1239 – 1242.

[2] Mateo, J. and J.M. Zumalacárregui (1996) Meat Science 44 (4), 255 – 273.

[3] Edwards, R.A., J.A. Ordóñez, R.H. Dainty et al. (1999) Food Chemistry 64, 461 – 465.

[4] Sunesen, L.O., V. Dorigoni, E. Zanardi and L. Stahnke (2001) Meat Science 58, 93 – 97.

[5] Siegmund, B. and W. Pfannhauser (1999) European-Food-Research-and-Technology 208, 336 – 341.

Data in the form of tables, charts and figures

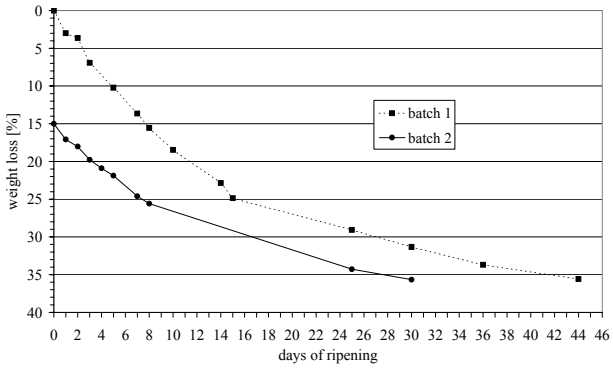

Fig. 1: Plot of weight until 35% loss.

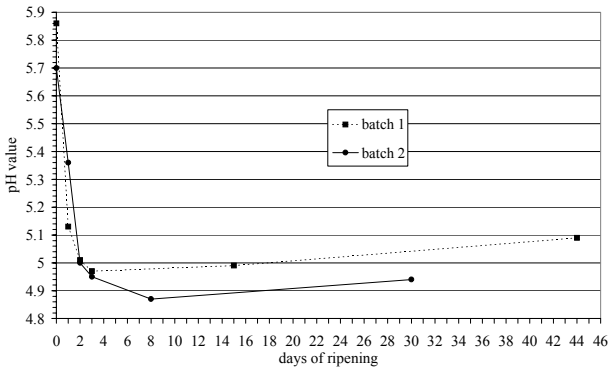

Fig. 2: Plot of pH change during ripening.

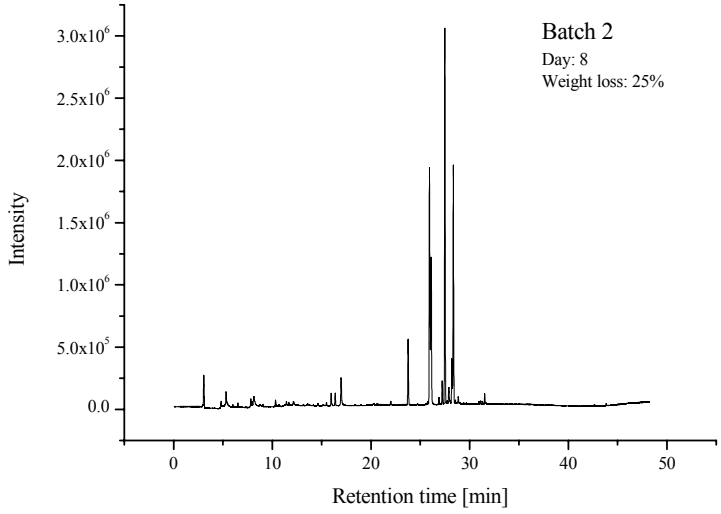

Fig. 3: Typical headspace chromatogram of a dry sausage sample. See table 1 for peak identifications.

Peak	Time	Compound	Origin of compound
1	5.33	Pentane	Lipid oxidation
2	6.52	Dimethyl-disulfide	Garlic/spice mixture
3	7.83	Hexane	Lipid oxidation
4	7.96	3-Methyl-pentane	Lipid oxidation
5	8.13	2-Butanone	Carbohydrate fermentation
6	10.34	3-Methyl-butanal	Amino acid catabolism
7	11.70	Heptane	Lipid oxidation
8	12.15	Pentanal	Lipid oxidation
9	15.97	3-Methyl-heptane	Lipid oxidation
10	16.38	Octane	Lipid oxidation
11	16.98	Hexanal	Lipid oxidation
12	22.02	Heptanal	Lipid oxidation
13	23.77	α-Pinene	Pepper/spice mixture
14	25.94	Pentamethyl-heptane	Lipid oxidation
15	26.11	β-Pinene	Pepper/spice mixture
16	27.23	α-Phellandrene	Pepper/spice mixture
17	27.49	3-Carene	Pepper/spice mixture
18	27.90	Tetramethyl-octane	Lipid oxidation
19	28.21	1-Methyl-4-(1-methylethenyl)-benzene	Pepper/spice mixture
20	28.36	Limonene	Pepper/spice mixture
21	28.86	Dimethyl-octane	Lipid oxidation
22	31.54	Nonanal	Lipid oxidation

Tab. 1: Volatile compounds identified in a dry sausage sample.

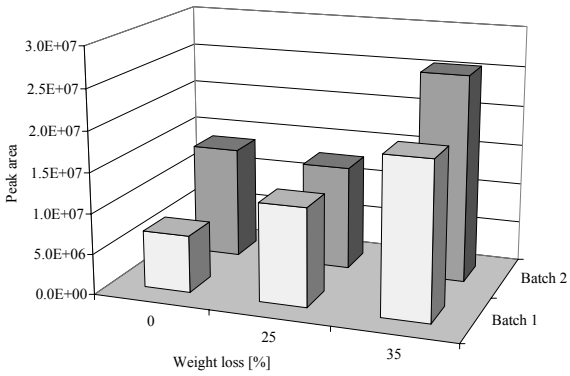

Fig. 4: Area of hexanal peaks at different ripening stages.

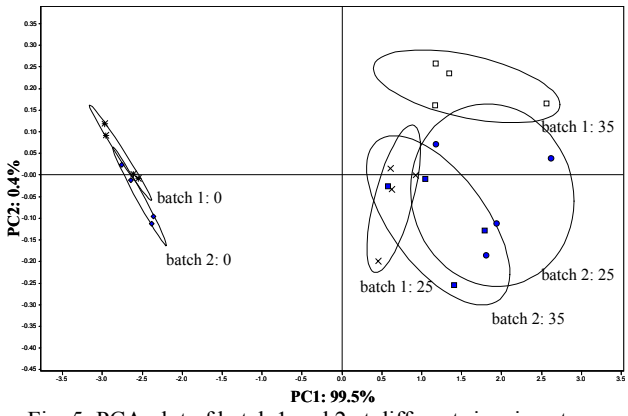

Fig. 5: PCA plot of batch 1 and 2 at different ripening stages.