INFLUENCE OF FRESHNESS OF MEAT AND FAT ON STORAGE STABILITY OF SLICED FROZEN DRY SAUSAGES

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Background:
During recent years, the consumption of frozen convenience food products has been steadily increasing. The oxidative stability of these products is often limited by ingredients like ham and dry sausage they contain.
Air–packed sausages are very critical because oxidation occurs very quickly [1]. A very critical point for storage stability is the freshness of raw materials, especially pork back fat, used to produce dry sausages. An important strategy to increase oxidative stability is to preserve the natural balance of oxidative factors in muscle foods by utilizing the right food processing techniques [2]. Fat content and the composition of fatty acids in lipid is very important in determining the development of lipid oxidation during storage [1].
Oxidation of fat is known to increase during frozen storage [3]. Furthermore, unsaturated fatty acids intensify this process.

Objectives:
The objective of this study was to investigate the effects of freshness of raw materials on the oxidation of sliced and frozen dry sausages by monitoring 2-thiobarbituric acid reactive substances (TBARS), hexanal, oxygen and sensory evaluation during storage.

Methods:
Dry sausage production: To get pork back fat with different levels of different freshness, it was bought exactly one day after slaughtering. After standardization the fat was cut into small pieces and was then mixed. One part was directly frozen **(batch 2)**, the second part was frozen after three more days **(batch 3)** and also after six days **(batch 4)**. In addition, lean pork was frozen one day after slaughtering **(batch 5)**. Sausages were produced with these raw materials immediately and after 0.5, 1, 2, 3, and 5 months. **Batch 1** is always fresh meat and fresh back fat.
The initial sausage mixture contained 40% lean frozen pork, 30% frozen pork back fat and 30% 3 mm minced beef. Other ingredients were added (g/kg) as follows: NaCl (28.0), $NaNO_2$ (0.05), monosodium ascorbate (0.5), sodium glutamate (0,5), white pepper (3.5), dextrose (4.0), lactose (5.0) and starter cultures *L. sakei* + *P. pentosaceus* (0,5). The mixture was stuffed in 65mm diameter R2 casings (Naturin, Germany) and placed in a ripening chamber under the following conditions of temperature and relative humidity: day 0 to 2, 24°C and 88-92% RH, day 3 to 5, 20°C and 85-88% RH; day 6 to 8, 18°C and 82-86% RH; day 7 to 15 or 16 16°C and 78-82% RH. The sausages were smoked after 2, 3 and 5 days. After reaching 25% weight loss, they were removed from the ripening chamber, cooled overnight to 5°C and sliced in 3mm slices.
The slices were put in tinplate cans (73/58) and stored at –18°C for 5 weeks. To reach a uniform contact of the slices to the surrounding air in the can, V-formed pieces of high-grade steel wire (∅ 5 mm) were put between the slices. Another part was stored in oxygen and light impermeable bags under vacuum at – 18°C for one year.

Oxygen: The gas to be measured was carried out of the can with an applied adhesive rubber with a syringe and injected in an oxygen analyzer, a solid cell type oxygen meter using a zirconia system solid electrolyte (LF 700, TORAY).

TBARS: A previously described [5] and modified [6] method was used as follows. Five ml of steam distillate of homogenised dry sausage (10g dry sausage + 100 ml distilled water + 1 ml sulphanilamide/N-(1-naphthyl)ethyldiamine solution (1:1), pH 1,5) were heated with 5 ml thiobarbituric acid (TBA) solution (100°C, 35 min) and the absorbance was measured at 538 nm. Based on the calibration curve obtained with 1,1,3,3-tetraethoxypropane, TBARS values were expressed in mg malondialdehyde/kg dry sausage. The analysis was performed in duplicate.

Hexanal: The homogenised dry sausage was distilled with an internal standard (2-butanol) as follows [7] (10g dry sausage + 100ml distilled water + 4ml 2-butanol, 250ppm). 2 ml of the first 10 ml of the steam distillate were heated (60°C, 50 min) and after that 1ml headspace gas was injected in a GC with fused-silica-capillary column (30m, ID 0.32mm, film thickness 0.25µm, Supelco USA), temperature program: 40°C for 5 min, from 40°C to 120°C at 5°C/min, 120°C for 5 min, injector 250°C, detector 250°C. Identification of GC peaks was based on a combination of 2-butanol-concentration and retention times.

Fatty acids: As described by Rule [8], to 300mg of the freeze-dried porkfat were added 200µl dichlormethane and 1.5ml 0.5M NaOH in methanol and heated for 10 Min at 90°C, 1ml boron-trifluoride in methanol was added and heated once again (10 min, 90°C). After extraction 100ml dist. water + 500µl hexan was added, shaked, spun at 2000 rpm and finally injected in a GC (capillary column 30m, ID 0.25mm, film thickness 0.2µm, Supelco USA). Temperature program: 150°C for 2 min, from150°C to 190°C at 4°C/min, from 190°C to 220°C at 15°C/min, 220°C for 20 min, injector 280°C, detector 250°C.

Sensory evaluation: A taste panel consisting of 10 members described the rancidity using a 10-point scale as follows: not perceived (0-1), slightly perceived (2-3), moderately perceived (4-5), strongly perceived (6-7) and very strongly perceived (8-9). The results shown in Figure 4 present averages of the ratings reported by the panellists.

Results and discussion:

After a five week storage period under air-accelerating conditions for the sliced and frozen dry sausage, significant differences of rancidity were found. They depend on the freshness of the pork back fat and on its storage time.

Batch 4, produced with fat being frozen 7 days after slaughtering shows the highest amount of the secondary oxidation products TBARS and Hexanal (Figures 1 + 2) and also a small content of oxygen (Figure 3). The increase in rancidity during the storage period of batch 3 is significantly smaller than that of batch 4 due to the use of fat which was frozen earlier after slaughtering.

Oxidation rancidity has not appeared in batch 2 during the first 2 months, but after this storage time, it also increased slowly.

During the frozen storage of pork back fat, the direct increase of TBARS and Hexanal is not very high. This was also shown by an other study [4], but the consequence of oxidation in sliced dry sausage is much higher.

The use of frozen lean pork (batch 5) has an smaller affect on oxidation processes, what was also found by others [1, 11].

Figure 1: TBARS after 5 weeks

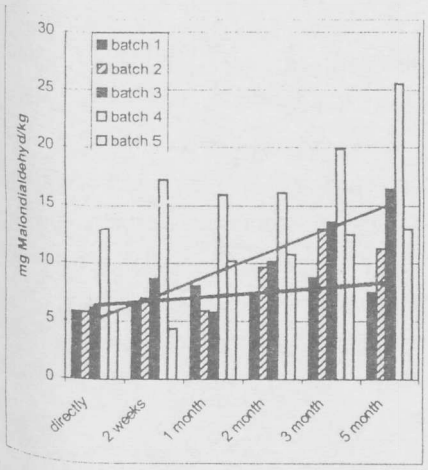


Figure 2: Hexanal after 5 weeks

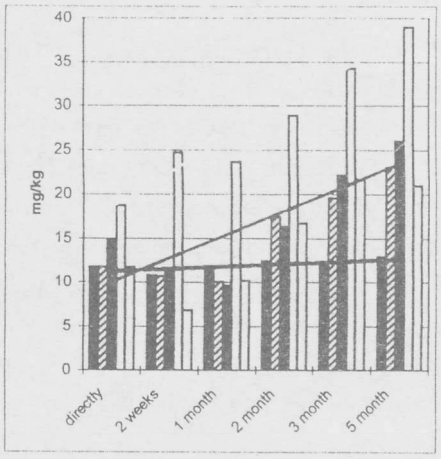
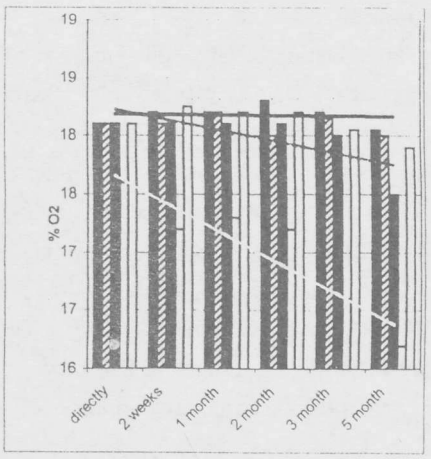


Figure 3: Oxygen in can after 5 weeks



In the case of vacuum-packed sausages, Hexanal and TBARS values increased very slowly. Even after a frozen storage of one year, no significant differences between the 5 batches could be found, which is an agreement with previously reported results [1, 9]. On a pizza, however, the product is always under air-accelerating conditions and so it is more important for our study.

The analytical data also correlate well with the sensory results as demonstrated in Figure 4. The increasing rancidity of batches 3 and 4 can be seen more clearly. The batches with directly frozen fat (2) or meat (5) had significantly better sensory results.

The content of unsaturated fatty acids constantly decreased during the storage of fat from batch 4 (Figures 5/6), due to auto-oxidation of lipids [3, 10]. This is one of the reasons for a smaller storage stability of dry sausages produced with this pork back fat.

Figure 4: Sensory description after 4 weeks

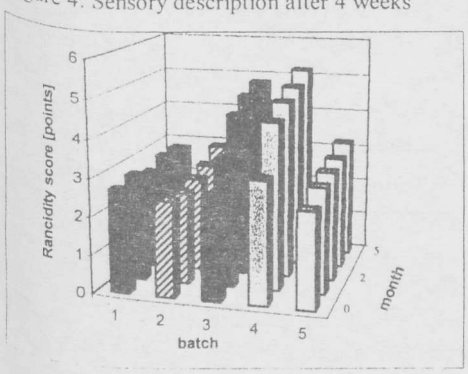


Figure 5: Fatty acids of porkfat, batch 2

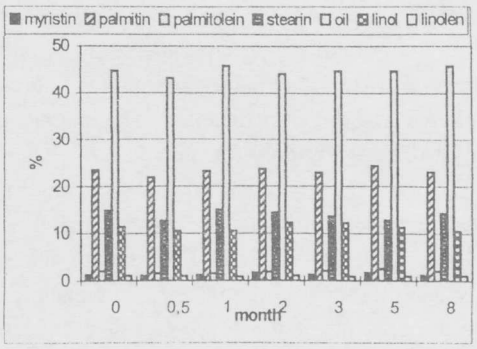
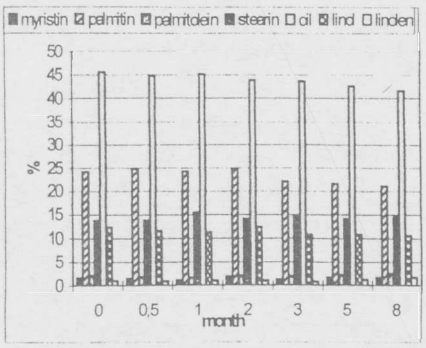


Figure 6: Fatty acids of porkfat, batch 4



Conclusions:

When producing dry sausage for pizza, the freshness of pork back fat is very important for later storage stability [12]. Fat has to be frozen as soon as possible after slaughtering so it can be stored for one or two months without problems in lipid oxidation. The oxidation of dry sausage will increase significantly with the storage time when using fat which is frozen later after slaughtering.

Also lean pork should be frozen freshly but not stored for more than two months to reach a stable dry sausage that can be used for pizza production.

Literature:

1. Ahn, D.U., D.G. Olson, C. Jo, X. Chen, C. Wu and J.I. Lee, (1998). Meat Science 49, 27-39
2. Decker, E.A., and Z. Xu (1998). Food Technol. 52 (10), 54-59
3. Stiebing, A., D. Kühne and W. Rödel (1993). Fleischwirtschaft 73(10), 1169-1172
4. Rickert,R., K. Winkler and H. Steinhart (2001). Lebensmittel-chemie 1/2001, 19
5. Tarladgis, B.G., B.M. Watts, M.T. Younathan and L.R. Dungan (1960). J.Am-Oil Chem. Soc.37, 44-48
6. Zipser, M.W. and B.W. Watts (1962). Food Technol. 16, 102
7. Lin J.C.C. and I.J. Jeon (1985). J. of Food Sci. 50, 843-846
8. Rule D. (1997). Meat Science 46, 23-32
9. Smith, J.J., S.C. Seideman, R.L. Rosenkrans, and J.L. Secrist (1985). J. of Food Protect. 48/3, 200-203
10. Chasco, J., M.J. Beriain and J. Bello (1993). Meat Science 34, 191-204
11. Miller, A.J., S.A. Ackermann and S.A. Palumbo (1980). J. of Food Sci. 45, 1466-1471
12. Houben, J.H., and B. Krol (1980). Meat Science 5, 57-70