# THE EFFECT OF CHOPPING CONDITIONS ON DRY SAUSAGE METABOLISM

VERPLAETSE, A.[1,3], VAN HOYE, S.[1] and DEMEYER, D.[1,2]

1. Onderzoekscentrum voor voeding, veeteelt en vleestechnologie
   University of Ghent, B-9230 MELLE, BELGIUM
2. Instituut voor biotechnologie, Vrije Universiteit,
   BRUSSELS, BELGIUM
3. Present adress : Ter Beke NV, R&D department,
   B-9950 WAARSCHOOT, BELGIUM

## SUMMARY

The effect of different chopping conditions on dry sausage metabolism is studied in two experiments, which differ only in time of salt addition. The results show that drying patterns are affected by degree of chopping. The extent of drying is highest in sausages with coarse particle structures. The initial rate of drying however is unchanged by the comminution time.
Patterns of carbohydrate and protein metabolism are not affected, which suggests that chopping procedure does not modify the dry sausage metabolism.
The time of salt addition in the chopping procedure does not influence the metabolic activity in the dry sausages, provided that the sausages obtained are commercially acceptable.
The experiments suggest that only initial rate of drying and not extent of drying significantly affects the dry sausage metabolism.

## INTRODUCTION

Fermented sausages are products made from comminuted meat and fat mixed with curing salt, spices and sugar and filled into casings. These products owe their organoleptic properties mainly to a fermentation carried out by lactic acid bacteria involving degradation of carbohydrates, proteins and lipids to various end products.
The patterns of carbohydrate and protein metabolism in dry sausages can be changed by altering various production parameters ; e.g. increasing the sausage diameter results in a shift of the metabolism towards less oxidation and acetate production because of more anaerobic conditions in the sausage (Demeyer et al, 1986).
The objective of this study is to determine the influence of different chopping conditions on carbohydrate and protein metabolism in dry sausages. The chopping procedures used differ in comminution time and in time of salt addition. They result in commercially acceptable products with different particle structure.

## MATERIALS and METHODS

### Preparation of sausages :

The sausages are prepared in a commercial meat plant with a 45 liter bowl chopper Kramer & Grebe. The rotation velocity of the bowl is 9 rotations per minute (rpm). Knive rotation speed is 1500 rpm .
The composition of the dry sausage mixture is given in table 1.
Two experiments which consisted each of two batches are carried out.The only difference between the two experiments is the time of salt addition.In experiment 1 salt is added shortly after addition of the pork back fat, whereas in experiment 2 salt is added at the end of comminution. The two batches have the same meat batter composition but a different chopping procedure is used. Batch A is chopped during a short period (approx. 4,5 minutes) and results in sausages with coarse particle structure. The fat particles have a mean diameter of ca 24 sq.mm . Batch B has a much longer comminution (approx. 7 minutes) which gives sausages with fine fat particles ; mean diameter ca 6 sq.mm .
The chopping procedures of experiments 1 and 2 are given in table 2.
The resulting mixture is stuffed into casings (Naturin 90mm) and the sausages (approx 2500g) are fermented for 72h at 22°C and 95% relative humidity (% RH), after which they are transferred to a drying room for 18 days at 15°C and 85% RH. During the fermentation period the sausages are daily smoked for ca 45 minutes.

### Sampling procedure :

In both experiments sausages are collected at 0,1,2,3,6,13 and 21 days after stuffing and immediately transported to the laboratory. Only analyses after day 21 are used in evaluation of stoichiometry of metabolism. A sufficient amount of the sausage is ground in a commercial meat grinder after removing the casing. The mixture is either used immediately or is vacuum packed in plastic bags and stored at -18°C.

### Chemical analyses :

Ground samples are analysed for total carbohydrates, lactic acid, acetic acid, ammonia,free amino acids, peptides, dry matter (DM) and pH.
Acidity (pH ) is measured by careful insertion of pointed electrodes (Ingold LoT406-M4) in the sausage (casing removed).
Dry matter is determined according to the ISO method R1442.
For the determination of total carbohydrates, lactic acid, ammonia, free amino acids and peptides the samples are extracted with 0.6N perchloric acid (De Ketelaere et al, 1974;Dierick et al, 1974). Aliquots are used for the determination of total carbohydrates by using the phenol-sulfuric acid method (Vandekerckhove, 1978), for the determination of lactic acid and ammonia by micro diffusion techniques (Conway, 1957, Pearson, 1973), for the determination of free amino acids and peptides by using the colorimetric ninhydrin-method (Vandekerckhove , 1978 ). The peptides present in the perchloric extract are hydrolyzed during 24h in 6N HCl previous to analysis. (Vandekerckhove, 1978).

Data analysis :

Data were analysed following a stoichiometric model described earlier.(Demeyer and Verplaetse, 1985; Demeyer, Verplaetse en Gistelinck, 1986; ) . This model assumes lactate and acetate production from carbohydrate through glycolysis with pyruvate as intermediate. Part of the carbohydrate is assumed to be completely oxidized to carbon dioxide and water with consumption of oxygen. The validity of the latter assumption has been tested during dry sausage metabolism.(Van Hoye and Demeyer, 1987). The model further assumes lactate and/or acetate production from amino acid fermentation with pyruvate as central intermediate and in molar amounts equal to ammonia.
Lipolysis with production of glycerol contributing to lactate and acetate production has not been incorporated in quantitative stoichiometry.

## RESULTS and DISCUSSION

In both experiments no difference in pH development and final pH is observed between batches. The ph after 21 days is the same for all sausages and is equal to 4.89-4.86 .
The increase in dry matter content of the sausages in experiment 1 and 2 is given in table 3.In both experiments the extent of drying is highest in batch A. The mean increase in dry matter content of batch A is 10.6% DM.The difference in final dry matter content is 1% DM and 3.6% DM in experiments 1 and 2 resp.
The results show that chopping procedure affects the drying pattern of dry sausages. Coarse sausages will be dried to a greater extent. This is in agreement with results of Stiebing and Rodel (1985 & 1987) who found also a difference in drying pattern between sausages with different fat particle sizes. The initial drying rate is not affected by comminution time and it takes several days of drying to establish a difference in dry matter content between batches ( see table 4).
Data are evaluated within the stoichiometric model of sausage metabolism in table 5.
It is clear that there is no signifikant change in pattern of sausage metabolism by comminution. The total amount metabolized in dry sausages is only slightly increased with increasing comminution time. In both experiments the proportion of hexose and amino acids to total pyruvate equivalents metabolized is ca 88 % and 12 % respectively.
A slight increase with comminution time is observed however in the proportion of substrate assumed to be completely oxidized to carbon dioxide and water. Longer comminution increased that proportion from 20.8 to 24.9 % and from 6.9 to 13.4 % in expt. 1 and 2 respectively. An obvious explanation for this finding may be the presence of more air in the sausage with longer comminution time.
Addition of salt at the end of chopping seems to lower the proportion of substrate that is completely oxidized.

Sausage protein metabolism of both experiments is shown in table 6 and is clearly not influenced by comminution time.
The effect of time of salt addition in the chopping procedure can be studied by comparing experiment 1 with experiment 2. It is evident that in both experiments comparable protein metabolic patterns are found, indicating that time of salt addition has no influence on sausage protein metabolism. The latter hypothesis will only hold when acceptable sausages without smearing are produced, because smearing results in a completely erratic drying process of the sausages.

## CONCLUSION

The results suggest that chopping procedure does not significantly affect carbohydrate and protein metabolism in dry sausages. The time of salt addition in the chopping procedure does not change the metabolism in dry sausages, provided that the sausages obtained are commercialy acceptable. Extent of drying but not initial rate of drying is affected by comminution. This suggests that only the initial drying rate and not the amount of drying can have a signifikant influence on the dry sausage metbolism.

## REFERENCES


Conway, E. (1957) In "Microdiffusion Analysis and Volumetric Error ", 4th ed., Crosby,Lockwood and son Ltd, London.
De Ketelaere, A.,Demeyer, D.,Vandekerckhove, P. and Vervaeke, I. (1974) J. of Food Sci., 39:297-306.
Demeyer, D. and Verplaetse, A. (1985) Proceedings semin. Innovative Meat Technology, Ghent.
Demeyer, D.,Verplaetse, A. and Gistelinck, M. (1986) Proceedings 32nd EMMRW congress ,Ghent.
Dierick, N.,Vandekerckhove, P. and Demeyer, D. (1974) J. of Food Sci., 39:301-304
Pearson, D. (1973) In "Laboratory techniques in food analysis", 1st ed., Butterworths, London.
Stiebing, A. and Rodel, W. (1985) Mitteilungsblatt Bundesanstalt fur Fleischforschung 88:6394-6398.
Stiebing, A. and Rodel, W. (1987) Fleischwirtschaft 67(9):1020-1030
Vandekerckhove, P. (1978) PhD thesis, University of Ghent, Ghent.
Van Hoye, S. and Demeyer, D. (1987) Mededel. Fac. Landbouww. RUG, 52:1549-1552.

**Table 1 :** Composition of the dry sausage mixture (% w/w)

| ingredient | amount |
|---|---|
| lean pork | 30.60 % |
| lean beef | 30.60 % |
| pork backfat | 35.00 % |
| salt | 2.85 % |
| glucose | 0.70 % |
| sodium ascorbate | 0.03 % |
| pepper | 0.09 % |
| nutmeg | 0.07 % |

A mixture of three day old sausages containing atypical streptobacteria was used as starter.

**Table 3 :** Influence of comminution on the increase of dry matter content during dry sausage production.

| | batch A | batch B |
|---|---|---|
| Experiment 1: | +10.4 % DM | +9.5 % DM |
| Experiment 2: | +10.8 % DM | +7.2 % DM |

Table 2 : Chopping procedure experiments 1 and 2

experiment 1

| ingredient | batch A n(1) | batch B n(1) |
|---|---|---|
| lean beef | 22 | 22 |
| lean pork+spices+glucose | 2 | 2 |
| pork back fat | 11 | 11 |
| salt | 4 | 26 |

(1) number of bowl rotations after addition of the ingredient

experiment 2

| ingredient | batch A n(1) | batch B n(1) |
|---|---|---|
| lean beef | 20 | 20 |
| lean pork+spices+glucose | 3 | 3 |
| pork back fat | 15 | 33 |
| salt | 3 | 3 |

(1) number of bowl rotations after addition of the ingredient

Table 5 : Effect of chopping procedure on stoichiometry of dry sausage ripening (*)

experiment 1

| | batch A | batch B |
|---|---|---|
| Metabolized | | |
| Total | 19.60 (1) | 19.80 (1) |
| % of total | | |
| hexoses | 87.2 % | 88.6 % |
| amino acids | 12.8 % | 11.3 % |
| Formed | | |
| % of total | | |
| lactate | 73.0 % | 69.2 % |
| acetate | 6.2 % | 5.9 % |
| oxidation | 20.8 % | 24.9 % |

(1) in mmoles pyruvate equivalents /100g DM

experiment 2

| | batch A | batch B |
|---|---|---|
| Metabolized | | |
| Total | 17.70 (1) | 18.60 (1) |
| % of total | | |
| hexoses | 88.7 % | 87.7 % |
| amino acids | 11.3 % | 12.3 % |
| Formed | | |
| % of total | | |
| lactate | 83.4 % | 77.0 % |
| acetate | 9.7 % | 9.6 % |
| oxidation | 6.9 % | 13.4 % |

(1) in mmoles pyruvate equivalents /100g DM

(*) Calculations described in Demeyer et al (1986)

**Table 4 :** Influence of comminution on the initial rate of drying during dry sausage production.(1)

| | batch A | batch B |
|---|---|---|
| Experiment 1: | +2.7 % DM | +2.4 % DM |
| Experiment 2: | +2.3 % DM | +2.1 % DM |

(1) initial rate of drying = increase in dry matter content during first three days of fermentation

**Table 6 :** Influence of comminution time on protein metabolism (1)

experiment 1

| production | batch A | batch B |
|---|---|---|
| ammonia | 35.0 | 30.8 |
| free amino acids | 107.9 | 106.1 |
| peptides | 35.95 | 34.6 |
| total | 178.85 | 171.5 |

experiment 2

| production | batch A | batch B |
|---|---|---|
| ammonia | 28.0 | 32.2 |
| free amino acids | 85.0 | 92.2 |
| peptides | 38.53 (2) | 45.68 |
| total | 151.53 | 170.08 |

(1) as mg N / 100 g DM
(2) production of peptides after 14 days instead of 21 days.