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Introduction

Depletion of nitrite during the curing process, the heat treatment and storage of cured meat products, is a well-known phenomenon. It has been pointed out that heat converts nitrite rapidly to forms which are undetectable as such (Greenberg, 1972) and that the nitrite loss ranges from 30 to 90 percent (Grever, 1973). The same process continues to take place during storage at room temperature under anaerobic conditions. According to Olsman (1973) the heat of activation of the nitrite depletion process is 13 to 14 kcal per mole of nitrite. Two days after processing at 71°C and storage at 5°C of luncheon meat type products, Sebranek (1973) was able to identify less than one-half of the added nitrite. In general, depending upon the product and the procedure used, less than 50% the original nitrite can be detected analytically by the time the product has been heat processed. Depletion continues during storage, so that most retail products contain 5 to 30 ppm of nitrite (Cassens, 1979). Veselinka Djordjević et al. (1980) found 51 to 68 percent of residual nitrite in a type of Yugoslav cooked salami (at 82°C for 210 min.), containing initially 3 and 12 mg% of nitrite respectively.

Due to the great diversity of cured meats being produced, an obvious requirement is to investigate the fate of nitrite in each individual meat product. We decided to examine the effect of a specific cooking treatment and cold storage on the level of residual nitrite in the concentric (peripheral, intermediate and central) layers of large diameter sausages (Ø 60 mm and Ø 100 mm).

Materials and Methods

Under practical conditions, a finely comminuted sausage mixture was prepared without ascorbate addition (water = 53.5 - 54.6%; proteins = 12.9 - 13.4%; fat = 28.0 - 29.8%) and filled into Faser Top Braun Ø 60 mm and Ø 100 mm casings. The sausages were cooked at 80°C - those of smaller diameter for 60 min., those with the wider diameter for 115 min., to ensure that a minimum temperature of 70°C was reached in the center of the product. After cooling with water at 18°C, the sausages were stored for 15 days at 8°C. By means of an "Ellab" thermocouple heat treatment was recorded in all three layers of the sausages. The residual nitrites (reaction according to Zambelli) were determined in the raw sausages, in the sausages one hour after processing, and on 1st, 8th and 15th day of storage. After the sausage ends had been cut off (1.5 cm), the concentric layers were cut apart using a metal drilling device. The thicknesses of the peripheral and intermediate layers of the smaller diameter sausage were each 1.1 cm and that of the central layer 1.6 cm. These measurements for the wider diameter sausages were 1.7 cm and 3.2 cm respectively.

All of the investigations were repeated three times.

Results and Discussion

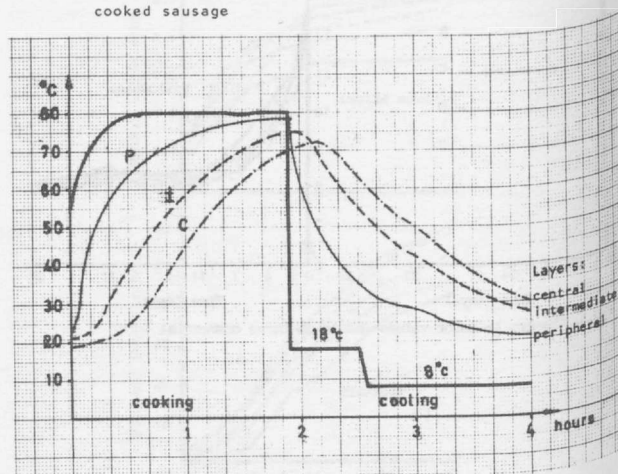
In the course of the cutting process and the hanging of stuffed sausages, interaction of nitrite with different muscle, connective and fatty tissue components takes place. Thus, the initial nitrite concentration of 200 mg/kg fell to 174.0 mg/kg in the smaller diameter sausage, and in the wider diameter sausage it was reduced to 178.7 mg/kg. These figures represent a detection of 87.0% and 89.3% respectively.

Heat treatment. Fig. 1 illustrates the heating of different Ø 100 mm cooked sausage layers during cooking at 80°C. The individual temperatures of the sausage prior to cooking were as follows: 21.7°C in the peripheral layer, 20.8°C in the inter-

mediate layer and 19.1°C in the central layer. Accordingly, the temperatures of these layers were increased relative to final temperature of the stuffing (18°C) by 3.7, 2.8 and 1.1°C respectively.

Heat treatment resulting from the cooking stage was completed as soon as a temperature of 70°C in the central layer had been reached. At that time the temperature of the intermediate layer was 5°C and that of the peripheral layer 7.4°C higher than the temperature in the center. During the initial period of cooling (35 min. at 18°C), the temperature of these layers went increased further. The highest temperature reached in the peripheral layer was measured as 77.6°C, that in the intermediate layer 75.8°C whilst the temperature in the center reached 72.3°C.

Fig. 1. Cooking and cooling patterns of peripheral (P), intermediate (I) and central (C) layer of large diameter (Ø 100 mm) cooked sausage



At the end of the period of cooling the temperature of the peripheral layer was as high as 35°C, that of the intermediate one 55.6°C and of the center 64°C. Even additional chilling in a chamber without air circulation at 8°C for 90 minutes produced no equilibration of temperature in the examined layers (21.1, 27.0 and 30°C respectively).

Table 1 shows the mean values of the contents and percentages of the residual nitrite detected in concentric Ø 60 mm and Ø 100 mm sausage layers, one hour after heat treatment has ended. It is evident that the residual nitrite level is highest in the central and the lowest in the peripheral sausage layers.

The level of residual nitrite in the Ø 60 mm sausages was lower in all layers than in the Ø 100 mm sausages. The mean value of the residual nitrite in all layers of the smaller diameter sausage was 120.5 mg/kg whilst in the Ø 100 mm sausage an additional 27.7 mg/kg of the residual nitrite was detected.

Table 1 - Contents and percentages of residual nitrite detected in concentric layers of the Ø 60 mm sausage cooked for 60 min. and the Ø 100 mm sausage cooked for 115 min. at 80°C

Layers of the sausage	Ø 60 mm sausage		Ø 100 mm sausage	
	mg/kg nitrite	% detection*	mg/kg nitrite	% detection*
peripheral	116.9	58.4	141.3	70.6
intermediate	120.4	60.2	146.6	73.3
central	124.2	62.1	156.6	78.3
AVERAGE:	120.5	60.2	148.2	74.1

*calculated on 200.0 mg/kg added nitrite

Assuming that depletion of nitrite starts from the moment of coming into contact with the meat, that is from the beginning of the curing, and continues during the cooking and cooling, the following conclusion may be drawn:

the depletion of nitrite in Ø 60 mm cooked sausages is 1.5 times higher than in 100 mm diameter sausages;

in neither of these cases did this depletion reach the 50 percent value, which is referred to in the literature several times as a general conclusion. Probably this occurs only when the nitrite is applied along with the ascorbate which was not the case in our experiments.

Storage. During the 15 day storage period, the depletion of nitrite continued in all of the layers of both sizes of sausages. The level of residual nitrite remained highest in the central layers, and dropped to its lowest level in the peripheral layers (Table 2).

Table 2 - Contents and percentages of residual nitrite detected in concentric layers of the large diameter cooked sausages during 15 days storage at 8°C

Layers of the sausages	Days of storage					
	1st		8th		15th	
	mg/kg nitrite	% detection	mg/kg nitrite	% detection	mg/kg nitrite	% detection
Ø 60 mm:						
- peripheral	105.0	52.5	92.0	46.0	82.2	41.1
- intermediate	109.3	54.6	97.0	48.5	84.9	42.4
- central	117.0	58.5	102.4	51.2	91.5	45.7
AVERAGE:	110.4	55.2	97.1	48.6	86.2	43.1
Ø 100 mm:						
- peripheral	114.7	57.3	96.1	48.0	89.6	44.8
- intermediate	121.5	60.7	97.0	48.5	91.9	45.9
- central	123.6	61.8	100.6	50.3	93.8	46.9
AVERAGE:	119.9	59.9	97.9	48.9	91.8	45.9

% detection is calculated on 200 mg/kg added nitrite

- Greenberg R.A., 1972. Nitrite in the control of Clostridium botulinum, p. 25. Proc. Meat Ind. Res. Conf., Chicago, Illinois.
- Grever A.B.G. 1973. Minimum nitrite concentrations for inhibition of clostridia in cooked meat products. Proc. int. Symp. Nitrite Meat Prod., Zeist, Pudoc, Wageningen.
- Olisan W.J. 1973. About the mechanism of nitrite loss during storage of cooked meat products. Proc. int. Symp. Nitrite Meat Prod., Zeist, Pudoc, Wageningen.
- Sebranek J.G., Cassens R.G. and Hoekstra W.G. 1973. Fate of added nitrite. Proc. int. Symp. Nitrite Meat Prod., Zeist, Pudoc, Wageningen.

Depletion of 50 percent of added nitrite in the examined cooked sausages was found within an average of 8 days storage at 8°C.

Conclusions

On the basis of the detected levels of residual nitrite in large diameter cooked sausages (Ø 60 and 100 mm), manufactured without addition of ascorbate, the following conclusions may be drawn:

- The level of residual nitrite varies between individual concentric layers of the sausage. It is always highest in the central layers, somewhat lower in the intermediate layers and lowest in the peripheral layers.
- The rate of nitrite depletion one hour after heat treatment was 1.5 times higher in the Ø 60 mm sausage than in the Ø 100 mm cooked sausage.
- Nitrite depletion effected by 60 min. cooking at 80°C of the Ø 60 mm sausage was substantially greater than that effected by 115 min. cooking at the same temperature of the Ø 100 mm sausage.
- Depletion of 50 percent of added nitrite was found to occur within an average 8 days storage of the finished product, irrespective of sausage diameter.

References

- Cassens R.G., Greaser M.L., Ito T. and Lee M. 1979. Reactions of Nitrite in Meat, Food Technology, 46-57.
- Djordjević Veselinka, Vuksan Branka, Radetić P., Djurdjica Hak and Mitković M. 1980. Contribution to examinations of the influence of certain factors on changes of nitrite content in meat, Tehnologija mesa, 287-290.