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EFFECT OF SULFUR-CONTAINING AMINO ACIDS ON THE SENSORY QUALITY OF CANNED LIVER SAUSAGE

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Keywords
liver sausage - Maillard reaction - sensory quality - sulfur-containing amino acids

Background
The annual quality tests of German meat products showed that there is a sensory quality problem with canned, finely comminuted liver sausages. In 1993, 9.6 % of the tested liver sausages had a negative burnt high-temperature-heated flavor (STIEBING, 1994). Liver sausage is one of the most heat sensitive meat products (WIRTH et al., 1971), even products heated at low temperatures can have a bitter and burnt taste. The reasons are Maillard reactions between amino acids and sugars of the liver. These reaction products are responsible for the burnt flavor and the dark brown color. The effect of sulfite to inhibit the nonenzymatic browning by blocking the carbonyl group is well known. Already PEARSON et al. (1966) reported that sulfite blocked much of the browning produced on heating fresh pork. But adverse reactions in some asthmatic individuals have been reported following ingestion of foods or beverages containing sulfites (FAN and BOOK, 1987). FRIEDMAN and MOLNAR-PERL (1990) reported that SH-containing amino acids such as cysteine, N-acetyl-cysteine, and reduced glutathione are nearly as effective as sodium bisulfite in preventing nonenzymatic browning of heated amino acid-glucose mixtures.

Objective
The aim of the experiments was to investigate, if sulfur-containing amino acids as N-acetyl-cysteine and reduced glutathione are able to inhibit the development of the burnt high-temperature-heated flavor in canned liver sausage.

Materials and Methods
Preparation of liver sausages
The liver sausages were made in all experimental batches with pig livers (25 %), coarsely defatted pork (30 %) and pork backfat (45 %). The levels of additives used were 17 g/kg nitrite curing salt (NPS) and 0.5 g/kg sodium ascorbate.
The gall bladder ducts and all other vessels were removed from the livers, and the prepared livers were chopped in a bowl chopper with NPS and sodium ascorbate. The meat and fat were heated together in a steam-jacketed cooking chopper to 65 °C (149 °F), NPS and sodium ascorbate were added, and the mixture was cooled down to 55 °C (131 °F). Liver and the additives N-acetyl-cysteine (NAC), reduced glutathione (GSH), and phosphate ($Na_4P_2O_5$) were added, and the emulsion was mixed for 2 min. The final concentrations of the additives in each batch are presented in Table 1. The liver sausage emulsions were prepared in four-kilogram batches. The emulsion was then filled in cans (250 g) and heated to an F-value of 5.0.

Sensory tests
To evaluate the effect of the additives, triangle-tests were carried out two to five days after the preparation. The control experiment (without additives) and the samples containing additives (NAC or GSH) were presented for the test. The panelists were additionally asked to identify samples having a more intensive burnt flavor.

Color measurement
The color of the canned liver sausages was measured with a Minolta-Chroma-Meter CR 200 with CIE-LAB-System (DIN 6174). The values are the mean of the L*,a*,b*-coordinates taken at 12 points on the surface (top, bottom, side).

Results and Discussion
Liver sausages with 0.01 - 0.03 % reduced glutathione were not distinguishable in the triangle test from the control experiment. At higher concentrations (0.06 - 0.30 %) reduced glutathione had a negative effect on taste and color. The sausages had a bitter taste and looked gray, L*,a*,b*-values being lower than that of control sample.

Canned liver sausages containing NAC in concentrations of 0.03, 0.06 and 0.08 % were not distinguishable from the respective control samples. The effect of a concentration of 0.15 % NAC in the liver sausages was significant (α=0.01). 12 persons out of 17 detected the difference. The experimental repetition confirmed this effect. 10 out of 17 persons detected the difference, and 9 among these 10 persons described the control sample as more intensively burnt than the sample with 0.15 % NAC. The results of the sensory tests were found to be highly significant (α=0.01) at 0.30 % NAC levels (n=17). From the 12 positive evaluations 11 panelists described the sample with NAC as less intensively burnt. However, these samples had an acid taste; the pH-value was lowered by 0.3 units in the samples in which 0.15 % NAC had been added. Hence, an experiment (trial V) was conducted with a combination of 0.15 % NAC and 0.25 % diphosphate. No lowering of pH and nearly no acid taste were observed in these samples. 13 out of 15 panelists detected the difference between the control sample and the sample with the additional combination. Furthermore, 12 of them described the control sample as possessing more intensive burnt flavor than the sample treated with NAC and diphosphate (α=0.01).

The addition of NAC had a positive effect on the color of the canned sausages. The lightness indicator, L*-value, was higher, i. e. the sausages were brighter in color; the b*-values were lower, i. e. the yellow color was less intensive compared to the control sample. JAUD (1993) also reported that the b*-values were closely correlated with the burnt high-temperature-heated flavor in liver sausages. The combination of NAC and phosphate had a positive effect on the color. The sausages looked more intensely red and had fresher appearance (higher a*-values).

MOLNAR-PERL and FRIEDMAN (1990) reported that unlike cysteine N-acetyl-cysteine and reduced glutathione produced minimal or no off-flavors at concentrations that inhibit browning in protein-containing foods. We found that reduced glutathione had no positive effect on the flavor of the finely comminuted liver sausages, maybe because of oxidation of the reduced glutathione to less reactive oxidized glutathione (GSSG), during the processing steps like chopping and filling. According to MOLNAR-PERL and FRIEDMAN (1990) the acylated derivative (NAC) may be more stable to oxidation and generally more reactive than cysteine. In experiments with l-cysteine in canned liver sausages, JAUD (1993) found that the inhibitory effect was not reproducible probably because of oxidation of cysteine to cystine.

Our investigations showed that a concentration of 0.15 % N-acetyl-cysteine improves the sensory characteristics of the canned liver sausages. The burnt high-temperature-heated flavor was minimized and the color was positively influenced. An acid taste could be compensated by the addition of 0.25 % diphosphate.

Although the nature of the inhibition processes is not completely understood, possibilities include suppression of free radical formation, interaction of the sulfhydryl compounds with intermediates formed during browning- thus trapping them from forming the final browning product(s) and reducing carbonyl groups or reacting with carbonyl groups and double bonds in browning products to form colorless compounds (FRIEDMAN and MOLNAR-PERL, 1990).

Conclusion

An addition of 0.15 % N-acetyl-cysteine and 0.25 % diphosphate to liver sausage emulsion before heating was able to minimize the burnt high-temperature-heated flavor significantly in canned liver sausages.

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Table 1: Concentrations of additives in each experimental batch [in %]

trial	additive	batch No.							
		1	2	3	4	5	6	7	8
I	NAC[a]	0.00	0.03	0.06	0.08	0.10	0.15		
II	GSH[b]	0.00	0.03	0.06	0.10	0.15	0.30		
III	NAC[a]	0.00	0.10	0.15	0.20	0.25	0.30	0.40	0.50
IV	GSH[b]	0.00	0.01	0.02	0.03				
V	NAC[a]	0.00	0.15	0.15[c]					

[a] NAC = N-acetyl-cysteine; [b] GSH = reduced glutathione; [c] with 0.25 % diphosphate