

## FORMING OF AROMA OF DRY-CURED SAUSAGES

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It is known that the taste and aroma of dry-cured meat products are the result of enzymatic and non-enzymatic conversions of meat raw materials components with the participation of microorganisms (1,2). The quality and quantity composition of volatile organic compounds responsible for the aroma of the products was studied in some types of dry-cured pork (1-5). It was shown that volatile compounds belong to the classes of alcohols, aldehydes, ketones, esters, sulfur-containing compounds. The role of microorganisms in aroma development remained unclear (1). Dry-cured sausages also contain natural ground spices, mainly black pepper and piment. The volatile compounds in these sausages were not investigated previously.

## PURPOSE

Study of composition of volatile organic compounds and dynamics of their changes in ripening and storage of dry-cured sausage.

## MATERIALS AND METHODS

Volatile organic substances were studied in 4 samples of the same dry-cured sausage: after 7 days (sample 1), 30 days (sample 2), 60 days (sample 3) and 120 days (sample 4) after filling casings. All the samples were stored at 10 °C. Extraction and concentration of volatile compounds were carried out by the method of simultaneous distillation-extraction with diethyl ether. Gas chromatography and chromat-mass-spectrometric analyses were carried out according to (6). The compounds were identified using the libraries of mass-spectra EPA/NBS and Willey, as well as on the basis of the values of retention indices. Found compounds are in the Table.

## RESULTS AND DISCUSSION

Fig. shows the chromatogram of the concentrate of the volatile components of the sample 4, which had the intensive, pronounced aroma of dry-cured sausage with a very weak fatty note. The concentrate of the sausage volatiles comprises mainly two groups of organic compounds: saturated and unsaturated aldehydes, mono- and sesquiterpenes. Also are found the ester, alcohols, free fatty acids with 14, 16 and 18 carbon atoms (Table). Contrary to dry-cured pork (1), mono- and sesquiterpenes originating from natural ground spices additionally contribute to the flavour formation of dry-cured sausage. The concentration of terpenes in sample 4 significantly exceeds concentration of aldehydes. In spite of the lower content of aldehydes as compared to terpenoids, their contribution to the aroma of the product is large, because their odour thresholds are much less than for terpenes.

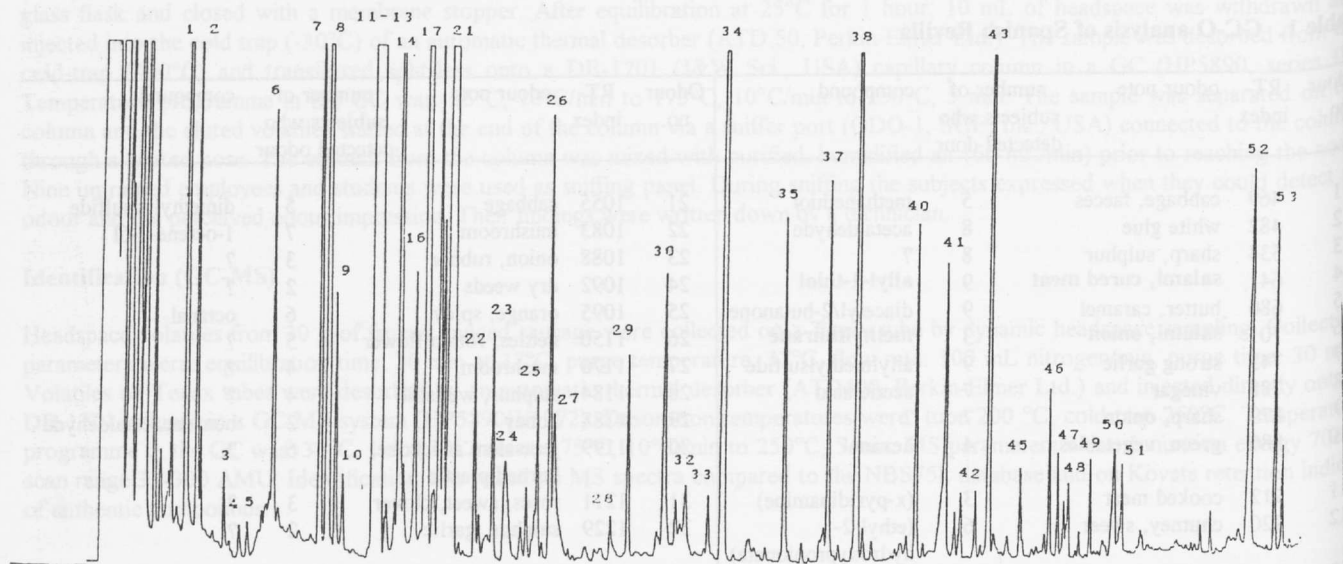


Fig. Chromatogram of dry-cured sausage volatiles

During ripening and storage of dry-cured sausage the quality and quantity composition of aroma-forming compounds changes. Concentration of the aldehydes C<sub>6</sub>-C<sub>7</sub> has not practically changed up to 60 days of sausage storage, the concentration of alcohols remained constant after 120 days of storage. New aldehydes with 8-13 atoms of carbon appeared in trace amounts only after 60 days of storage. At 120 days of storage the concentration of all the aldehydes increased sharply, especially of hexanal and 2,4-decadienal.



reaching the content about 1 ppm. This fact suggests about intensification of oxidative processes in raw-cured sausage after 60 days of ripening, i.e. during storage of the ready product. Similar increase in the concentration of aliphatic aldehydes was marked during storage of raw-cured pork, however in that case their content increased already on the 25th day of product storage and continued during 211 days, than decreased (1). Probably, in our case the presence of natural spices inhibited the oxidation of raw materials lipids in samples 1-3, that led only to insignificant increase of volatile aldehydes concentration. The dynamics of the changes of volatile terpenes content in dry-cured sausage during its storage is different. The trace amounts of terpenes in sample 1 suggest that the volatile components of spices are in bound condition. During sausage storage, as result of enzymatic and hydrolytic degradation of precursors the content of volatile terpenoids constantly increases. The most sharp increase in the concentration of monoterpenes was in the period from 7 to 30 day of storage, i.e. during ripening of the sausage. For instance, the content of  $\alpha$ -pinene increased 64-fold. During the next 30 days of sausage storage, the concentration of terpenes increased only 2-10-fold, during the following 60 days - 2-3 fold.

Compounds identified in the samples of dry-cured sausage and their relative content

No. of peak in Fig.	Compound	Content, ppm samples of sausages				No. of peak in Fig.	Compound	Content, ppm samples of sausages			
		1	2	3	4			1	2	3	4
1	Hexanal	0.04	0.04	0.04	0.95	28	2(Z)-Nonenal	-	-	-	0.01
2	Butyl acetate	0.20	0.04	0.03	0.30	29	2(E)-Nonenal	-	-	-	0.09
3	2-Hexenal	0.01	0.01	0.01	0.03	30	4-Terpineol	-	0.04	0.09	0.12
4	2-Hexenol	0.01	0.02	0.02	0.01	31	$\alpha$ -Terpineol	-	0.17	0.90	0.02
5	Hexanol	0.03	0.03	0.02	0.01	32	Decanal	-	+	0.02	0.03
6	Heptanal	0.01	0.02	0.01	0.020	33	2,4(E,E)-Nonadienal	-	-	-	0.03
7	$\alpha$ -Thujene	+	0.06	0.09	0.56	34	n-Dodecane (int.st.)	5.00	5.00	5.00	5.00
8	$\alpha$ -Pinene	0.01	0.64	1.65	3.94	35	2-Decenal	-	-	0.01	0.15
9	2-Heptenal	-	+	0.02	0.10	36	4-Ethylguaiacol	-	0.03	0.07	-
10	Camphene	-	+	+	0.03	37	2,4(E,Z)-Decadienal	-	-	0.01	0.17
11	Sabinene	0.03	1.50	8.12	16.40	38	2,4(E,E)-Decadienal	-	-	0.01	0.95
12	$\beta$ -Pinene	-	0.28	2.55	4.51	39	Not identified	-	0.04	0.10	-
13	Ocimene	-	0.04	0.13	0.30	40	2(E)-Undecenal	-	-	0.01	0.15
14	$\beta$ -Mircene	+	0.09	0.16	0.90	41	Dodecanal	-	0.01	0.02	0.13
15	Octanal	-	-	-	0.02	42	Copaene	-	0.01	0.03	0.03
16	Phellandrene	+	0.04	0.08	0.12	43	tr-Cariophyllene	-	0.07	0.20	0.84
17	3-Carene	+	0.60	1.20	2.46	44	Not identified	-	0.03	0.06	-
18	$\alpha$ -Terpinene	-	0.02	0.03	0.01	45	$\alpha$ -Humulene	-	+	0.01	0.04
19	p-Cymene	-	0.03	0.07	0.38	46	Tridecanal	-	-	0.01	0.07
20	Limonene	-	0.02	0.03	0.14	47	Sesquiphellandrene	-	+	0.01	0.05
21	1,8-Cineole	-	0.80	2.03	4.40	48	Myristicin	-	+	0.02	0.03
22	2-Octenal	-	-	-	0.09	49	Elemicin	-	+	0.03	0.04
23	$\gamma$ -Terpinene	-	0.04	0.08	0.10	50	Farnesene	-	+	0.03	0.05
24	Octanol	-	0.11	0.92	0.03	51	2-Tridecenal	-	-	-	0.04
25	Nonanal	-	0.02	0.04	0.07	52	Acid C <sub>14</sub>	0.02	0.04	0.08	0.17
26	$\alpha$ -Terpinolene	-	+	0.02	0.20	53	Hexadecanol	+	0.03	0.06	0.15
27	Linalool	-	0.01	0.04	0.10						

Note: - compound not found

+ concentration of the compound is less than 0,01 ppm

## CONCLUSION

It was shown that the aroma of dry-cured sausage is formed during the whole period of ripening and storage of the product as a result of enzymatic and non-enzymatic degradation of proteins and lipids of meat raw materials and the used spices. The quantity content of volatile organic compounds can serve as a criterion for the objective control of sausages ripening during their storage and for quality evaluation.

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