CHANGES OF VOLATILE COMPOUNDS IN POULTRY MEAT DURING STORAGE

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Background

The volatiles compounds are formed in poultry meat during various reactions, e. g. hydrolysis of proteins, deamination and decarboxylation of peptides and amino acids, lypolysis of fats and consequent degradation of fatty acids during enzymatic and/or autooxidation processes. All these reactions can lead to the quality changes, particularly formation of off-flavours. On the other hand, volatile constituents and particularly their changes during storage can indicate about chemical, enzymatic and microbial processes in the meat.
Different methods are used to isolate meat aroma constituents from the food matrix. Static and dynamic headspace, simultaneous distillation/ extraction in a Likens Nickerson apparatus [1] have been most widely used in meat aroma research. Recently, an effective solid phase microextractiom sampling was successfully introduced to collect aroma components in headspace and aqueous media. The choice of the method first of all depends on the analysis goals; headspace analysis provide data which can be closely related to the olfactory assessment, while distillation and extraction methods are associated with the overall composition of volatile and most often intermediate volatility compounds in the food matrix.

Objectives

This study was aimed at the determination of volaitle compounds in poultry meat by simultaneous distillation/extraction techniques in a Likens Nickerson apparatus and assessment of their changes during storage.

Methods

Poultry breast meat from 3 month age chickens was obtained from the local poultry plant. Before the analysis the breasts were stored at −18 °C during 3 months. The samples were defrosted to +4 °C and stored during 5 days (Lithuanian regulations permit to store poultry meat at this temperature during 4 days). Suspension containing 50 g of meat in water at the ratio of 1:4 was placed in a Likens Nickerson apparatus sample flask and the process of distillation/extraction was carried out during 1 h. As a solvent, 20 mL of diethyl ether were used. The extracts were dried over anhydrous Na_2SO_4 during 12 hrs in the freezer. The excess of the solvent was evaporated with the gentle stream of nitrogen just before gas chromatography and mass spectrometry (GC/MS) analysis which was performed on the coupled *Carlo Erba MEGA 5300* GC and *Varian 3400–Finnigan MAT 95 MS* equipped with the fused silica capillary BP5 column (25 m length, 0.25 mm id). GC separation temperature was programmed from +60 °C to +260 °C at the rate of 3 °C/min. Mass spectra were obtained in the electron ionisation mode at 70 eV, scanning m/z from 24 to 300. The compounds were identified by matching MS data obtained with the references present in the "*Nist 98*" (*National Institute of Standards and Technology*) database and comparing linear retention indexes (RI) with those provided in different literature sources.

Results and discussion

Totally, more than 120 constituents were detected in the extracts, most of them were identified positively (good match of MS and RI) or tentatively (good match of MS). Typical total ion chromatogram (TIC) of the extract is provided in Fig. 1, the main constituents are tabulated in Table 1.
Saturated and unsaturated aldehydes, alcohols, carboxy acids, some sulphur and other compounds were found in the extracts of poultry distillates. 3-Hydroxy-2-butanone, unidentified (most likely oxygenated) compound and hexanal were the most abundant volatile constituents in the freshly defrosted meat. The content of some higher aldehydes and free fatty acids was also considerable. The changes in the percentage and absolute amount, expressed in arbitrary units (a. u.), of some compounds during storage was quite remarkable. For instance, the content of one of the most volatile aldehyde, 2-methylbutanal was detected in the stored meat while in the fresh samples this compound was not recorded. It is known that 2-methylbutanal is formed from amino acid leucine in the course of Strecker degradation.
The content of some other volatile aldehydes, particularly, 2-butenal, pentanal, hexanal significantly decreased after storage. It can be suggested that these compounds are constantly formed in the frozen meat from the relevant amino acids and/or by other chemical mechanisms; however, they are lost during storage at +4 °C due to the evaporation and/or chemical changes. Striking decrease in the content of unidentified compound (no. 10) was determined after 5 days of storage. The changes in the amount of 3-hydroxy-2-butanone which has been reported to be as a meat aging indicator [2] were not remarkable; although judging from the peak area of this compound in a. u. some increase ocurred after 5 days of storage. The content of some less volatile aldehydes, particularly *cis* and *trans* 2,4-decadienals, increased during storage several times. These compounds are generally formed from linolenic acid by the gradual β-oxidation mechanism. It is likely that some additional amount of hexadecanal, both in the freshly defrosted and stored meat, was formed during the reduction of hexanoic acid used during distillation as an antifoaming agent. However, quite high amount of this aldehyde was previously reported in chicken meat by the other authors [3]. The content of some fatty acids, particularly tetradecanoic, 9,12-octadecadienoic and octadecanoic, also increased during storage, most likely due to the poultry fat lypolysis. Izopropyl myristate can be pointed out as the major ester, the content of which significantly increased during storage. The content of the two important sulphur compounds, dimethyl disulphide and dimethyl trisulphide, was less than 0.3 % in the freshly defrosted meat and this content remarkably decreased during storage. Taking into account low odour threshold of sulphur compounds, such changes are likely to influence sensory profile of meat samples during storage. Some unidentified lower volatility compounds absent in the freshly defrosted meat were detected in the stored samples (no. 42-44).

Conclusions

More than 120 constituents were detected in the samples of poultry meat, which were subjected to a simultaneous distillation and extraction process in a Likens Nickerson apparatus. The changes in the content of some important aldehydes and fatty acids during storage were evident. The content of some most volatile compounds decreased after 5 days of storage, while some higher aldehydes, particularly

unsaturated decadienals were intensively formed at the same period. These changes can be explained by the well-established biochemical and chemical mechanisms taking place in the meat during its storage.

Pertinent literature

1. S. T. Likens, G. B Nickerson. Detection of certain hop oil constituents in brewing products. Am. Soc. Brew. Chem. 1964, Proc 5.
2. D. S. Mottram. Flavour formation in meat and meat products: a review Food Chemistry. 1998, 62, 415-424.
3. N. Ramarathnam, L. J. Rubin, L. L Diosady. Studies on meat flavor. 4. Fractionation, characterization and quantitation of volatiles from uncured and cured beef and chicken. J. Agric. Food Chem. 1993, 41, 939-945.

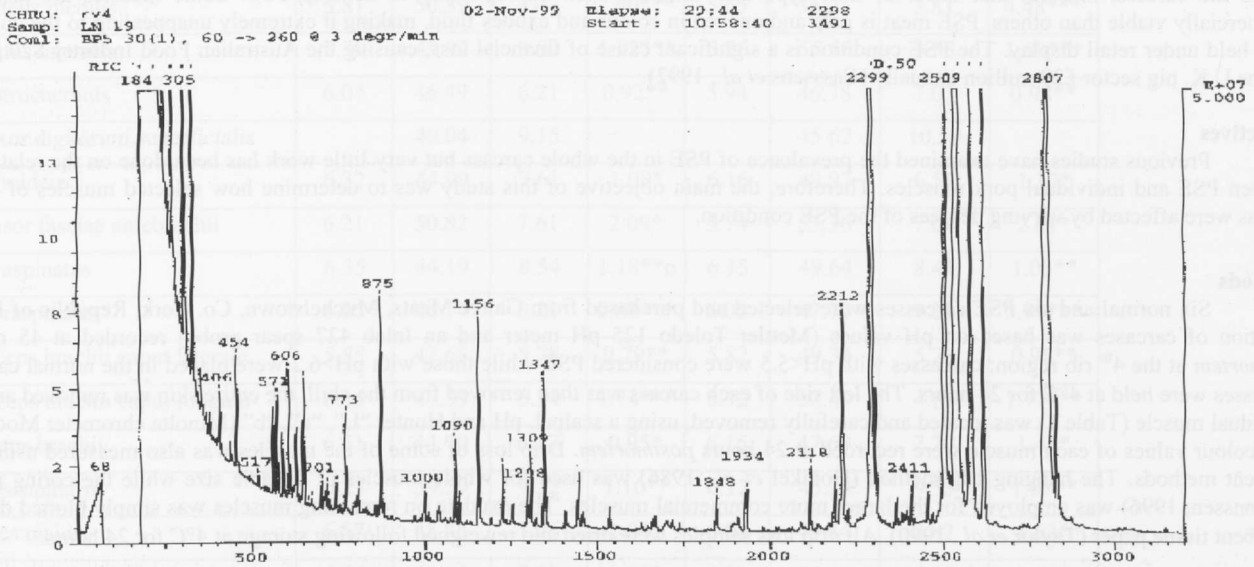

Fig. 1. Total ion chromatogram of volatile compounds extract isolated from poultry breast in a Likens Nickerson apparatus

Table 1. The composition of poultry meat volatile compounds isolated in a Likens Nickerson apparatus

No.	Compound	Freshly defrosted meat		Stored 5 days meat		No.	Compound	Freshly defrosted meat		Stored 5 days meat	
		%	a.u.	%	a.u.			%	a.u.	%	a.u.
1.	2-Butenal (E)	0.59	39	0.00	0	29.	Benzothiazole	1.18	78	1.33	139
2.	2-Methylbutanal	0.00	0.00	0.08	8	30.	Carvone	0.05	3	0.23	24
3.	1-Butanol	0.35	23	0.69	72	31.	2-Decenal, (E)	0.29	19	0.78	82
4.	1-Penten-3-ol	0.23	15	0.10	10	32.	Nonanoic acid	0.12	8	0.45	47
5.	Pentanal	0.71	47	0.00	0	33.	2,4-Decadienal, (E, Z)	0.24	16	1.19	125
6.	3-Hydroxy-2-butanone	2.35	155	1.96	206	34.	2,4-Decadienal, (E, E)	0.68	45	4.31	452
7.	Dimethyl disulphide	0.27	18	0.03	3	35.	Dodecanoic acid	0.21	14	0.45	47
8.	1-Pentanol	0.97	64	0.53	56	36.	2-(Methylthio) benzothiazole	0.21	14	0.20	21
9.	Hexanal	5.73	378	2.96	310	37.	Pentadecanal	0.30	20	0.44	46
10.	ni (oxygenated comp.)	5.24	346	0.35	37	38.	Tetradecanoic acid	1.88	124	2.62	275
11.	Furfural	0.14	9	0.19	20	39.	Hexadecanal	23.64	1560	19.83	2080
12.	4-hydroxy-4-methyl-2-pentanone	0.00	0	0.24	25	40.	Izopropyl myristate	0.55	36	2.19	230
13.	1-Hexanol + oc	0.14	9	0.15	16	41.	Pentadecanoic acid	0.17	11	0.42	44
14.	Heptanal	0.47	31	0.32	34	42.	ni (229B, 257, 272)	0.00	0	0.68	71
15.	3-(methylthio) propanal	0.00	0	0.22	23	43.	ni (229B, 243, 257, 272)	0.00	0	0.42	44
16.	2-Heptenal (E)	0.38	25	0.55	58	44.	ni (43, 58, 146, 159B,231)	0.00	0	0.29	30
17.	Benzaldehyde	0.42	28	0.47	49	45.	9-Hexadecenoic acid	5.52	364	4.97	521
18.	Dimethyl trisulphide	0.30	20	0.04	4	46.	Hexadecanoic acid*	17.58	1160	19.07	2000
19.	1-Octen-3-ol	0.52	34	0.51	53	47.	9,17-Octadecadienal	0.45	30	0.23	24
20.	2-Pentyl furan	0.30	20	0.29	30	48.	9-Octadecenal (Z)	4.97	328	2.62	275
21.	Octanal	0.50	33	0.47	49	49.	Octadecanal	2.67	176	1.44	151
22.	2,4-Heptadienal (E,E)	0.05	3	0.17	18	50.	9,12-octadecadienoic acid	5.15	340	5.72	600
23.	Phenyl acetaldehyde	0.12	8	0.26	27	51.	9-Octadecenoic acid	8.33	550	9.06	950
24.	2-Octenal, (E)	0.47	31	0.68	71	52.	Octadecanoic acid	0.70	46	1.60	168
25.	Nonanal	0.86	57	1.25	131		**Total**	96.35	6359	93.77	9835
26.	2-Nonenal, (E)	0.12	8	0.31	32		Other compounds				
27.	Octanoic acid	0.11	7	0.26	27		(not presented in Table)	3.65	241	6.23	653
28.	Decanal	0.14	9	0.19	20						

ni – not in NIST98 library (the main m/z provided in the brackets); oc – other compound; a. u. – arbitrary unit, related to the peak area; *remarkable amount of a hexadecanoic acid is most likely an artefact arising from the used pf palmitic acid which was used as a antifoaming agent during distillation.