IDENTIFICATION OF VOLATILE COMPOUNDS FROM COOKED BEEF, PORK, AND MIXED SAMPLE AND THEIR DIFFERENTIATION USING HS-SPME-GC-MS

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I. INTRODUCTION

Meat flavour, the key factor in consumer acceptance, is formed during cooking due to the production of some volatile compounds. These compounds are derived from some precursors, namely fats, low molecular weight water-soluble compounds, reducing sugars, and amino acids as a result of the Maillard reaction, lipid degradation, and Strecker degradation, which contribute the most to the characteristic meat flavour [1]. Different meat species have distinct flavours. HS-SPME-GC-MS has been proven as a simple, efficient method for volatile extraction from meat and is used for species authentication and identifying adulteration [2]. Beef and pork are the most common meat consumed worldwide; used in this study for their volatile analysis will further help with their authentication based on flavour components.

II. MATERIALS AND METHODS

A random sampling method was chosen. Ground beef and pork loin from three different animals cooked with pan-roasting at 160°C for 6 min were used. And from the cooked meat, mixed samples were prepared. Each batch has two replication. Exact, 2.5 g of cooked meat and 5 mL of 25% NaCl solution were mixed and homogenized [2]. An Agilent 7890B gas chromatograph coupled with an Agilent 5973C mass spectrometer with an autosampler (PAL, Agilent) was used to detect and quantify volatiles. Supelcowax-10 capillary column was used. Volatile extraction was done by HS-SPME, and the condition was as follows: 30 min extraction at 60°C with 50/30 µm DVB/CAR/PDMS fiber. All the data were analysed using SAS 9.4. software (SAS Institute Inc., Cary, NC, USA) and Metaboanalyst 5.0.

III. RESULTS AND DISCUSSION

A total of 72 individual volatiles were identified and divided into aldehydes, alcohols, ketones, pyrazines, and hydrocarbon groups [2]. Table 1 shows the major compounds present in all the samples. Aldehydes were the most abundant compounds in terms of number and quantity, followed by alcohols [2]. Most of the compounds identified came from lipid degradation afterward the Maillard reaction. A PLS-DA model was developed; the first two principal components were explained by 41.2% of the total variance and showed a clear separation of the samples where beef and pork were situated far, and the mixed sample lies between them, indicating species or group identification possibilities based on volatile profile. Compounds with a VIP score (>1) are considered important shown in Figure 1(B). Different compounds were correlated with the meat groups indicated by the color box on the right side of the Figure. For instance, hexanal was positively correlated with pork, whereas 1-octen-3-ol was with beef, which helps to distinguish between them and followed a trend in the mixed samples [3]. Aldehydes with carbon 6-10 were the major volatile compounds and were mainly responsible for the flavour [1]. Ketones & hydrocarbons have a lower influence than aldehydes, alcohols & pyrazines on the overall flavour.

Table 1. Major compounds present in all the meat samples

Compounds	RT (min)	LRI	m/z	Concentration (µg/kg)				Identification method
				Beef	M1	M2	Pork	
Aldehydes								
2-methyl butanal	4.22		57	14.75±1.41	41.33±8.53	29.31±2.31	13.8±1.59	ms
3-methyl butanal	4.39		58	13.66±1.49	21.34±2.24	17.45±1.17	10.30±1.22	ms
Hexanal	11.10	1050	56	65.35±3.59	58.72±8.66	94.91±1.71	289.12±46.5	Lri, ms
Heptanal	15.28	1175	70	46.31±6.24	44.35±5.22	44.14±3.46	55.64±5.04	Lri, ms
Octanal	19.17	1287	43	100.9±16.34	100.3±14.4	88.75±6.85	91.38±8.77	Lri, ms
Nonanal	22.85	1394	57	276.67±22.9	267.9±31.0	255.46±5.53	259.11±20.9	Lri, ms
Decanal	26.55	1501	57	31.09±0.03	30.14±5.71	29.61±3.16	14.9±0.4	Lri, ms
2-undecenal	32.98	1759	57	26.59±.59	29.43±5.03	19.14±.07	8.81±1.21	Lri, ms

Benzaldehyde	27.42	1530	106	51.78±7.43	47.16±.90	42.72±.77	26.99±.87	Lri, ms
Benzeneacetaldehyde	30.66	1651	91	69.70±1.81	56.2±.74	54.16±1.82	32.82±2.97	Lri, ms
Hexadecanal	38.92	2141	57	50.27±12.9	28.8±8.9	28.8±4.94	9.67±.71	Lri, ms
Ketones								
2-Octanone	19.02	1282	58	2.93±.53	7.6±1.61	6.63±.92	1.27±.10	Lri, ms
2-decanone	26.37	1495	58	4.28±.99	11.34±2.74	10.67±1.37	6.02±.78	Lri, ms
Alcohols								
1-Pentanol	17.59	1242	42	8.33±.82	7.09±.16	6.86±.13	7.77±.98	Lri, ms
1-Octen-3-ol	24.57	1444	57	124.74±31.5	119.79±1.6	84.92±10.24	94.99±11.75	Lri, ms
Heptanol	24.77	1450	56	28.06±2.98	32.86±3.58	33.81±2.93	23.24±1.37	Lri, ms
1-Octanol	28.17	1556	56	42.75±4.05	52.99±5.09	52.49±3.31	34.11±2.23	Lri, ms
2-ethyl-1-hexanol	26.02	1484	57	43.29±3.65	45.85±5.70	50.55±5.29	40.15±3.43	Lri, ms
1-dodecanol	36.38	1962	55	3.25±.38	5.87±.33	5.71±.21	2.69±.71	Lri, ms
Pyrazines								
Methyl pyrazine	18.23	1262	94	2.16±.06	5.20±.50	3.46±.13	1.85±.05	Lri, ms
Trimethyl pyrazine	23.10	1403	122	30.79±4.49	72.90±7.65	62.67±2.28	37.08±4.97	Lri, ms
2-acetylpyrrole	36.62	1978	94	4.20±.77	3.66±.55	3.22±.25	1.68±.22	Lri, ms
2,5-dimethyl pyrazine	20.25	1318	108	14.10±1.4	30.03±1.21	23.65±1.28	10.89±1.07	Lri, ms
2-ethyl-6-methyl pyrazine	22.44	1382	121	6.99±1.35	15.43±1.90	10.70±.88	6.54±.65	Lri, ms
2-ethyl-5-methyl pyrazine	22.66	1389	121	21.57±5.78	33.0±3.74	27.94±1.78	11.78±.96	Lri, ms
Hydrocarbons								
Undecane	11.66	1091	57	3.96±.63	4.80±.64	3.87±.16	2.21±.30	ms, std
2-pentyl furan	16.96	1224	81	27.37±5.71	24.19±5.51	19.09±2.82	18.44±3.61	Lri, ms
Tridecane	19.60	1299	57	10.24±1.73	8.17±1.01	7.26±.68	2.37±.35	ms, std
2-Octyl furan	27.63	1537	81	5.07±.12	7.21±.87	7.14±.59	2.31±.09	Lri, ms
Dodecane	15.94	1195	57	4.96±.35	5.91±.68	5.46±.25	3.27±.49	Lri, ms
Heptadecane	31.82	1700	67	3.29±.36	3.84±.52	3.0±.48	2.35±.71	Lri, ms

Data are presented as mean ± SE. M1 indicates (80% beef & 20% pork); M2 indicates (60% beef & 40% pork).

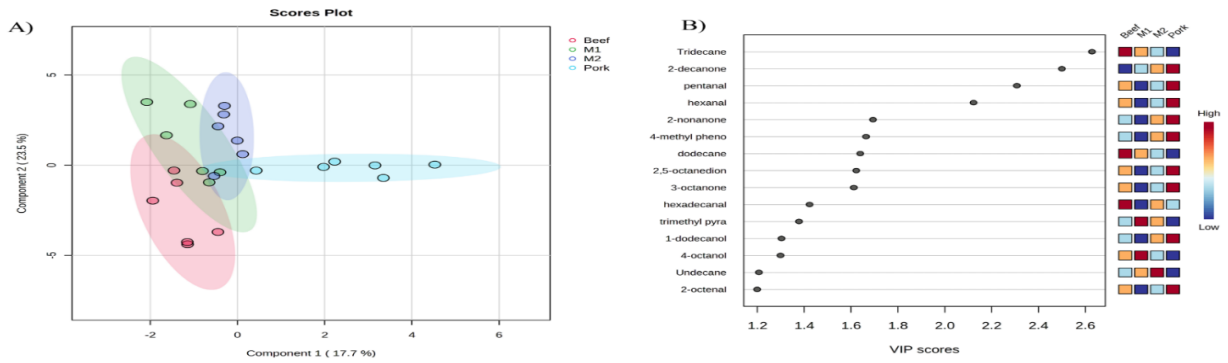

Figure 1. a) PLS-DA score plot of the compound identified from the beef, pork, and mixed samples; b) Significant compounds screened by Variable importance in projection (VIP) value.

IV. CONCLUSION

HS-SPME-GC-MS could be an easy, reliable method for volatile flavour analysis. Multivariate data analysis can distinguish meat groups and provide insights, helping to identify adulteration with more than one species.

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