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Aroma Compounds Profile In Skin And Meat From Beijing Roasted Duck (#368)

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Introduction

Beijing Roasted duck is Chinese traditional food, and very famous due to rich aroma. The key aroma compounds of roasted duck are still not well clear and systematically analyzed. Combination of detecting and recombination model can avoid inaccurate drawback of traditional method by single gas chromatography-olfactometry-mass spectrometery (GC-O-MS), and be able to accurately identify aroma compounds of products. The objective of the study was to confirm key aroma compounds and aroma profile of Beijing roasted duck by using headspace solid-phase microextraction/ gas chromatography-olfactometry-mass spectrometry (HS-SPME-GC-O-MS), odor activity value (OAV) and flavor omission experiments.

Methods

2.1 Sample preparation

The four most representative brands of Beijing roasted ducks were sampled from traditional restaurants in Beijing, China. The ducks had the same growth management with a daily age of 38 days and a weight of about 2 kg. The ducks were roasted 60 min at 250 and the roasted leg skin and meat were selected. The nonanal (99.5%), octanal (99%), 2-furfurylthiol (97%), 1-octen-3-ol (98%), 2-methyl-3-heptanone (99%) (internal standard) and n-alkanes (C7-C40, ≥97%) (external standard) and other standards were purchased.

2.2 Detection and recombination experiments of aroma compounds

The extraction and detection of aroma compounds were carried out by using HS-SPME-GC-O-MS/SIM. The identification analysis was operated by comparison with the mass spectrometry library, retention indices (RI), odor qualities and authentic flavor standards. The quantitation analysis was determined by 2-methyl-3-heptanone as internal standard and 5-point internal standard curves of authentic flavor standards. The key aroma compounds of Beijing roasted duck were confirmed by OAV, flavor recombination and omission experiments based on triangulation test of sensory evaluation.

2.3 Statistical analysis

The aroma compounds from six roasted duck of each brand were analyzed. All results were operated repeatedly for six times. All statistical analyses of aroma compounds were conducted by SPSS 19.0 software (IBM Corporation, USA). The heatmap analysis of aroma compounds was made by Origin 2018 software (OriginLab Corporation, USA). The results were expressed as the mean ± standard deviation.

Results

As shown in Table 1, 41 aroma compounds were determined in Beijing roasted duck, mainly containing aldehydes, ketones, alcohols, acids, phenols, sulfur-containing compounds and nitrogen-containing compounds. The sulfur-containing compounds and aldehydes had higher contents, such as methional (9.67-157.34 ng/g), dimethyl trisulfide (17.92-103.49 ng/g), 2-furfurylthiol (11.05-165.00 ng/g), hexanal (11.35-778.87 ng/g), nonanal (30.74-1567.33 ng/g) and (*E, E*)-2,4-decadienal (53.89-85.62 ng/g).

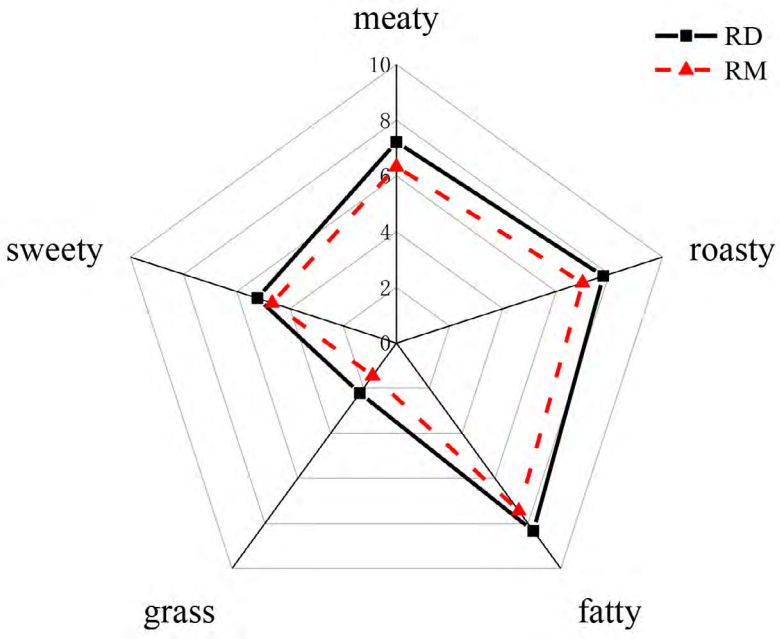
As shown in Figure 1, 18 aroma compounds with OAV higher than 1 were determined, including 12 aldehydes, 3 sulfur-containing compounds and 1 alcohol, such as 2-furfurylthiol (2209.32≤OAV≤32999.37), dimethyl trisulfide (3584.83≤OAV≤20698.97), methional(48.36≤OAV≤786.72), octanal (69.71≤OAV≤371.88) and (*E, E*)-2,4-decadienal (269.47≤OAV≤428.12).

As shown in Figure 2, aroma recombination and omission experiments demonstrated 9 aroma compounds significantly contributed to the characteristic aroma of Beijing roasted duck. These 9 key aroma compounds were 2-furfurylthiol, dimethyl trisulfide, hexanal, heptanal, octanal, nonanal, methional, 1-octen-3-ol and (*E, E*)-2,4-decadienal, among which the 2-furfurylthiol and dimethyl trisulfide significantly affected the aroma of roasted duck (p <0.01). The sensory evaluation score of recombination model with 9 aroma compounds was 4.5 points (0-5). The aroma characteristic of Beijing roasted duck were fatty, roasty and meaty aroma.

Conclusion

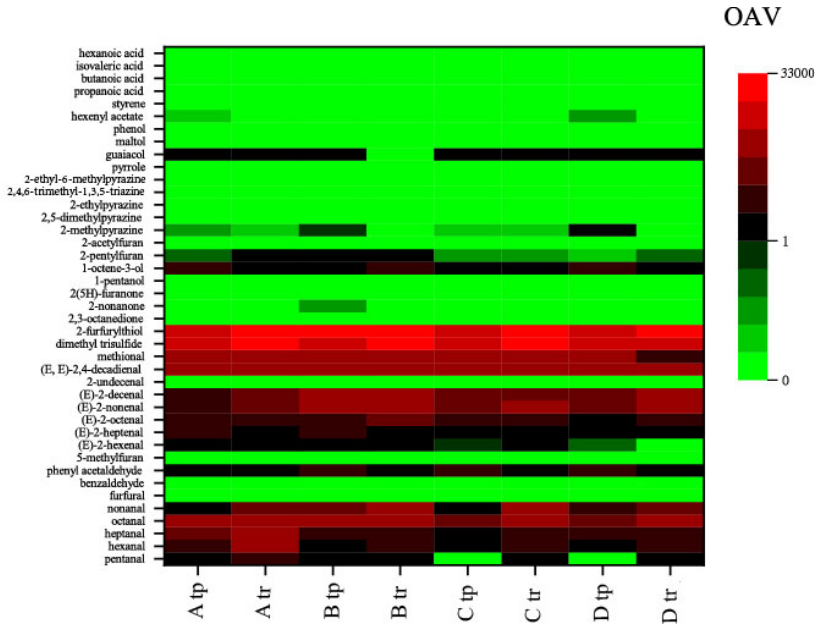
The key aroma compounds of Beijing roasted duck were 2-furfurylthiol, dimethyl trisulfide, hexanal, heptanal, octanal, nonanal, methional, 1-octen-3-ol and (*E, E*)-2,4-decadienal. The major aroma profile of Beijing roasted duck were strong fatty, roasty and meaty.

Notes



Aroma profile of Beijing roasted duck (RD) compared with that of the aroma recombination model (RM)
RD, roasted duck; RM, recombination model.

Notes



Heatmap analysis of aroma compounds

A tp, roasted duck A leg skin; A tr, roasted duck A leg meat; B tp, roasted duck B leg skin; B tr, roasted duck B leg meat; C tp, roasted duck C leg skin; C tr, roasted duck C leg meat; D tp, roasted duck D leg skin; D tr, roasted duck D leg meat.

Notes

compounds (ng/g)		roasted duck A		roasted duck B		roasted duck C		roasted duck D	
		leg skin	leg meat	leg skin	leg meat	leg skin	leg meat	leg skin	leg meat
aldehydes	pentanal	137.75±23.44	356.87±59.41	23.35±5.94	35.33±9.51	2.81±0.33	42.66±7.42	2.46±0.48	60.04±4.77
	hexanal	86.08±13.91	778.87±115.47	44.40±5.65	68.04±31.18	12.49±0.61	74.42±14.17	11.35±0.45	84.73±4.03
	heptanal	184.15±34.21	620.68±102.37	125.38±29.70	133.10±60.98	13.42±2.57	104.17±38.96	42.02±8.63	91.14±14.57
	octanal	108.40±11.64	260.32±56.33	92.20±11.07	125.30±51.75	48.80±1.90	118.20±37.54	53.43±2.29	90.38±12.44
	nonanal	30.74±24.93	739.09±304.46	450.19±55.42	1567.33±361.21	62.16±10.76	902.61±356.69	235.39142.64	690.92±47.80
	furfural	11.28±1.72	4.79±1.32	5.14±0.72	3.95±2.00	5.63±0.46	3.12±0.91	3.13±0.28	1.52±0.20
	benzaldehyde	8.81±3.31	25.58±5.60	15.91±10.42	27.83±13.66	4.40±1.48	24.68±7.79	8.29±2.13	26.85±6.32
	phenyl acetaldehyde	29.78±12.88	13.91±2.60	142.26±24.46	31.29±12.10	133.44±19.24	35.30±10.07	137.64±34.11	26.72±4.55
	5-methylfuran	1.59±0.62	-	0.28±0.13	-	0.72±0.05	0.51±0.14	-	-
	(E)-2-hexenal	206.04±36.94	183.95±55.23	182.92±53.56	68.69±9.88	36.05±7.42	41.56±9.16	29.91±6.12	6.85±1.25
	(E)-2-heptenal	130.24±18.21	92.32±15.60	228.43±18.56	58.07±11.22	49.00±11.26	28.72±2.66	117.28±24.02	35.75±8.31
	(E)-2-octenal	57.00±22.94	198.66±85.59	163.42±27.09	334.91±54.96	52.97±7.52	131.10±31.18	39.82±3.16	151.04±30.24
	(E)-2-nonenal	10.73±3.66	24.33±3.32	36.17±8.57	55.65±6.70	14.11±2.00	31.54±9.70	13.47±0.41	47.34±7.47
	(E)-2-decenal	11.45±10.75	76.90±7.04	62.94±18.12	67.21±20.22	20.68±1.66	34.09±14.27	20.86±3.80	45.62±14.39
	2-undecenal	-	-	0,88±0,16	1,45±0,94	0,39±0,05	0,96±0,18	0,40±0,07	1,56±0,67
	(E, E)-2,4-decadienal	69.01±4.55	53.89±1.52	81.58±5.73	76.27±3.54	71.31±2.61	67.60±2.96	56.43±1.47	85.62±9.90
ketones	2,3-octanedione	2.98±0.43	80.88±25.50	6.41±1.02	58.33±13.34	1.55±0.19	28.72±4.15	1.49±0.13	40.46±2.63
	2-nonanone	0.01±0.00	0.01±0.00	7.11±1.21	0.01±0.00	0.43±0.08	0.83±0.19	0.99±0.21	0.21±0.04
	2(5H)-furanone	4.72±1.84	2.89±0.68	4.12±0.88	3.24±0.64	3.75±0.79	4.11±0.56	3.64±0.31	3.20±0.66
alcohols	1-pentanol	3.78±0.99	8.03±4.82	1.87±0.18	2.85±1.12	-	0.17±0.04	-	-
	1-octene-3-ol	10.47±2.79	8.04±2.23	9.33±7.07	15.13±8.61	5.28±1.04	3.79±2.59	14.48±4.36	7.98±0.50
acids	propanoic acid	6.05±2.07	-	2.79±1.01	1.27±0.19	1.48±0.24	0.77±0.24	0.99±0.09	0.61±0.13
	butanoic acid	6.72±1.92	0.93±0.31	8.45±3.37	1.91±0.49	2.19±0.70	0.91±0.26	2.96±0.46	1.72±0.23
	isovaleric acid	5.30±1.05	4.45±1.96	2.37±1.85	-	1.27±0.27	-	0.48±0.07	0.78±0.18
	hexanoic acid	8.27±1.10	12.36±3.02	6.10±1.45	8.22±2.99	3.58±0.99	2.85±0.83	3.14±0.62	4.60±1.28
esters	hexenyl acetate	19.38±7.50	-	-	-	-	-	27.32±5.21	-
phenols	guaiacol	17.41±6.57	5.89±1.55	13.48±3.42	-	18.96±1.65	10.47±1.94	4.16±0.87	8.38±0.88
	maltol	9.79±3.10	0.57±0.20	9.74±2.75	-	13.72±3.27	1.96±0.34	4.40±1.04	1.10±0.34
	phenol	13.32±6.79	0.84±0.26	1.70±0.71	0.67±0.28	15.78±1.65	7.8±2.95	2.25±0.13	1.73±1.07
sulfur- containing compounds	methional	63.23±18.87	80.54±27.61	132.14±22.77	74.34±21.99	65.08±28.65	26.81±5.31	157.34±19.60	9.67±6.93
	dimethyl trisulfide	17.92±4.58	103.49±26.86	35.09±9.08	57.60±26.58	23.00±4.38	55.18±11.19	24.33±2.84	21.74±6.21
	2-furfurylthiol	11.05±1.87	149.04±35.34	61.55±11.92	165.00±43.86	44.29±7.34	132.48±24.43	44.70±5.27	57.00±12.07
nitrogen-containing compounds	2-methylpyrazine	29.87±11.63	19.37±3.83	53.64±23.62	11.58±4.48	18.16±1.90	12.50±4.54	62.77±12.79	9.95±1.20
	2,5-dimethylpyrazine	4.30±1.50	5.01±1.05	13.57±3.25	3.52±1.81	3.55±0.41	1.87±0.54	15.34±3.15	2.09±0.25
	2-ethylpyrazine	2.03±0.72	-	4.02±0.81	-	2.05±0.89	-	4.68±1.28	1.93±0.24
	2,4,6-trimethyl-1,3,5-triazine	-	-	2.65±0.51	0.98±0.26	-	-	-	-
	2-ethyl-6-methylpyrazine	1.40±0.50	-	3.39±1.03	1.88±0.82	-	0.80±0.17	6.30±1.58	0.57±0.09
	pyrrole	2.91±0.78	-	2.43±0.86	-	0.77±0.06	-	2.11±0.54	3.14±0.53
furans	2-pentylfuran	4.16±0.81	6.56±1.44	7.81±1.01	7.92±2.04	2.90±0.20	3.45±0.54	2.04±0.29	4.00±0.53
	2-acetylfuran	4.86±0.76	2.91±1.06	6.79±0.57	10.64±3.70	3.46±0.85	5.33±1.85	6.41±1.71	2.88±0.48
hydrocarbon	styrene	1.04±0.29	5.29±1.50	4.27±0.70	3.53±1.47	1.73±0.16	3.58±1.59	1.97±0.38	2.95±0.59

Quantitation of aroma compounds in skin and meat from leg of Beijing roasted duck

A tp, roasted duck A leg skin; A tr, roasted duck A leg meat; B tp, roasted duck B leg skin; B tr, roasted duck B leg meat; C tp, roasted duck C leg skin; C tr, roasted duck C leg meat; D tp, roasted duck D leg skin; D tr, roasted duck D leg meat.

Notes