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Volatile Phenolic Derivatives and its Role in Chinese Traditional Smoke-cured Meat

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Abstract: Chinese traditional smoke-cured meat (bacon, beef, mutton and chicken) was analysed with regard to its content of volatile phenolic derivatives. Volatile phenolic derivatives were trapped by adsorbing, condensing, and dissolving in organic solvent (ether and n-pentane), using the Nitrogen Purge-and-Trap (NPT) and the Nitrogen Purge-and-Steam Distillation (NPSD) method. Qualitative and quantitative characterizations of the extract were performed by means of gas chromatography-mass spectrometry and gas chromatography with a flame ionization detector, respectively. In all, 24 volatile phenolic derivatives were detected in Chinese traditional smoke-cured meat. Among all detected volatile phenolic derivatives, 12 phenol and alkylphenols, 10 methoxyphenols and 2 other phenols were detected. Phenols originated mainly from the pyrolysis of lignin when the meat was smoked. 4 phenols was new volatile phenolic derivatives in smoked food. These compounds included 5-methylguaiacol, 5-propenylguaiacol, phenol acetate and 2,6-di-tert-butyl-4-(N,N-dimethylaminomethyl)phenol. Volatile phenolic derivatives may be important not only for the odor of Chinese traditional smoke-cured meat, but also for the preservation of the smoke-cured meat and for color development.

Key words: Aroma volatiles, phenolic derivatives, smoke-cured meat, methoxyphenols, alkylphenols, guaiacol

INTRODUCTION

Chinese traditional smoke-cured meat is a traditional food of the Chinese. Smoke-cured bacon, beef, mutton and chicken are the major kind of Chinese traditional smoke-cured meat. Phenolic derivatives are very important compounds in smoked products. The aim of this study is to apply an analytical technique for determination of volatile phenolic derivatives in Chinese traditional smoke-cured meat (bacon, beef, mutton and chicken) and to search for its action in Chinese traditional smoke-cured meat.

MATERIALS AND METHODS

Materials and reagents: Chinese traditional smoke-cured meat (bacon, beef, mutton and chicken) was prepared on our previous report method[1]. Waters Sep-Pak-C18□USA□©, oxygen-free nitrogen gas (99.999%, China). Other reagents were purchased from J&K Chemical Ltd.(Switzerland), ether was dried over K_2CO_3 and distilled.

Preparation of extracts: Ground smoke-cured meat (bacon or beef or mutton or chicken 200.0 g) placed in a 1000 mL flask. 400 mL Distilled water was added , and the contents were refluxed for 40 min in a oil bath. The cooked smoke-cured meat samples were cooled to room temperature, respectively. The Nitrogen Purge-and-Trap (NPT) technique[2] and the Nitrogen Purge-and-Steam Distillation (NPSD) technique[1] were employed in extracting volatile phenolic derivatives of Chinese traditional smoke-cured meat. The NPT technique was employed in extracting bacon, beef, mutton and chicken and the NPSD technique was employed in extracting bacon and beef.

Quantitation of the individual components (GC-FID): Quantitative characterizations of the extract were performed by means of gas chromatograph with flame ionization detector (FID). A HP-6890 gas chromatograph (USA) equipped with a DB-5 capillary column [30 m×0.25 μm(i.d)×0.25μm] and FID were used. Analysis was carried out by using helium as the carrier gas, with the column temperature maintained initially at 60□ for 2 min and then programmed from 60□ to 260□ at a rate of 10 □ min, where it was held for 8 min. Quantitation of the individual constituents identified the smoke-cured meat volatile concentrates was carried out with 1,2-dichlorobenzene (4.9 mg mL^{-1} in n-pentane) as the internal standard. From the peak areas of different known concentration of 1,2-dichlorobenzene (RT about 6.000 min), the sum of

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individual constituents present in smoke-cured meat (bacon or beef or mutton or chicken) was added in the different trapping fractions of the volatile concentrates, and expressed in terms of milligrammes per kilogramme of smoke-cured bacon or beef or mutton or chicken, respectively.

Gas chromatograph-mass spectrometric (GC-MS): Qualitative characterizations of the extract were performed by means of gas chromatograph-mass spectrometry. A Finnigan TRACE GC-MS (USA) equipped with a DB-5 capillary column [30 m×0.25 mm(i.d)×0.25 μm] was used. The GC condition was the same as above. The source and analyzer temperatures were 200□ and 250□ respectively. The ionization voltage applied was 70 eV. Mass spectra obtained were compared with those of known compounds in the Mainlib, Replib, Wiley, Nist library by using computer and were analyzed. Some compounds were confirmed by comparison with commercial products.

RESULTS AND DISCUSSION

Volatile phenolic derivatives identified in Chinese traditional smoke-cured bacon, beef, mutton and chicken are given in Table 1. In all, 24 volatile phenolic derivatives are detected in the different fractions of the volatile concentrates in smoke-cured bacon, beef, mutton and chicken. Among all detected volatile phenolic derivatives, some of them are detected in other smoked products, but 5-methylguaiacol, 5-propenylguaiacol, 2, 6-di-tert-butyl-4-(N,N-dimethylaminomethyl)phenol and phenol acetate aren't reported in other smoked food.

According to previous report, smoked meat flavor and aroma are mainly due to the phenols present in wood smoke[3] and are usually responsible for tangy flavour[4-10]. Daun[8] reportes that guaiacol, 4-ethylguaiacol, and 2, 6-dimethoxyphenol are most important compounds for tangy flavour. These compounds are detected in our test. Other phenols have smoky or approximately smoky odor, such as phenol, o-cresol, p-cresol, 3-methylphenol, 3-ethylphenol, 2,4-xylenol, 3,4-xylenol, p-ethylphenol, 2,4,5-trimethylphenol, 4-methylguaiacol, 4-propylguaiacol and eugennol[4,6,8,11,12]. Some of volatile phenolic derivatives are vague in organoleptic character, but should make contributions to the aroma of Chinese traditional smoke-cured meat on the basis of their structural formulae. It appears clearly that the volatile phenolic derivatives are responsible for the tangy flavour of the Chinese traditional smoke-cured meat.

10 Methoxyphenols are detected in our test, and they

Table 1: Volatile phenolic derivatives identified in Chinese traditional smoke-cured meat

		Bacon		Beef		Mutton	Chicken
RT (min)	Phenolic derivatives	NPT method (10^{-3} mg kg^{-1})	NPSD method	NPT method (10^{-3} mg kg^{-1})	NPSD method	NPT method (10^{-3} mg kg^{-1})	NPT method (10^{-3} mg kg^{-1})
	Phenol and alkylphenols						
5.140±0.007	phenol[a]	ND[c]	8.2259[d]	ND	5.2264	ND	ND
6.159	O-cresol[a]	ND	ND	ND	0.2453	ND	ND
6.946±0.067	p-cresol[a]	TR[a]	2.2598	ND	8.3340	TR	ND
7.305	3-methylphenol[a]	ND	ND	ND	ND	ND	0.1006
7.918±0.479	3-ethylphenol[a]	TR	ND	2.4991	1.9682	ND	ND
8.029±0.029	2,4-xylenol[a]	ND	ND	ND	1.4356	ND	0.3266
8.359	3,4-xylenol[a]	ND	2.4679	ND	ND	ND	ND
8.404±0.218	p-ethylphenol[a]	ND	TR	ND	ND	ND	2.9721
9.347±0.011	2,4,5-trimethylphenol[b]	ND	1.3143	ND	0.6589	ND	ND
10.180	o-tertbutylphenol[a]	ND	0.2819	ND	ND	ND	ND
13.151±0.543	4-methyl-2,6-di-tert-butylphenol[a]	TR	0.8125	2.0910	0.5152	0.02440	0.1405
22.256±0.428	2,21-methylenebis-(6-t-butyl-4-methyl)phenol[b]	ND	0.1885	0.06125	ND	ND	0.3129
	Methoxyphenols						
7.752	gualacol[a]	ND	ND	TR	ND	ND	ND
8.853±0.211	4-methylguaiacol[b]	ND	ND	TR	ND	0.04673	0.5515
9.312	5-methylguaiacol[b]	ND	ND	TR	ND	ND	ND
10.026±0.043	4-ethylguaiacol[a]	TR	0.9379	ND	2.4410	ND	0.1453
10.778±0.167	2,6-dimethoxyphenol[a]	ND	0.6973	ND	ND	ND	0.03140
11.014±0.350	4-propylguaiacol[b]	ND	ND	ND	0.5428	ND	0.06981
11.105±0.568	5-propenylguaiacol[b]	ND	ND	0.02342	ND	ND	0.3711
11.760	eugennol (4-allylguaiacol)[b]	ND	ND	ND	ND	0.01445	ND
11.951±0.725	isoeugenol (4-propenylgualacol)[a]	ND	1.2830	ND	0.6313	ND	ND
13.8760.220	2,3,5-trimethoxytoluene[b]	ND	0.1852	ND	0.2651	ND	1.8012
	others						
5.462±0.008	phenol acetate[a]	TR	ND	ND	0.2667	ND	ND
15.690	2,6-di-tert-butyl-4-(N,N-dimethylaminomethyl)phenol[b]	ND	ND	0.2499	ND	ND	ND

[a]Definitive identification: via mass spectra plus refrence compound; [b]Tentative identification: based on only mass spectra data; [c]ND: not detected; [d]the sum of the different trapping fractions;*TR: trace

have antioxidant activity[13]. This is important reason why Chinese traditional smoke-cured meat can store about a year in room temperature. Some phenols in the smoke vapor phase also contribute to color development[11,14].

CONCLUSION

24 Volatile phenolic derivatives were detected in Chinese traditional smoke-cured meat. 4 phenols was new volatile phenolic derivatives in smoked food. Volatile phenolic derivatives may be important not only for the odor of Chinese traditional smoke-cured meat, but also for the preservation of the smoke-cured meat and for color development.

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