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Study on volatile and semi-volatile compounds of *ginseng* in different area of Changbai Mountain

ZHAO Jinhua, YANG Cui, WANG Juan, LI Donghao*

(*Key Laboratory of Natural Resource of the Changbai Mountain and Functional Molecular (Yanbian University), Ministry of Education, Yanji* 133002, *China*)

Abstract: A rapid analysis method was established to investigate volatile and semi-volatile compounds in *ginseng* of Changbai Mountain by gas purge microsyringe extraction (GP-MSE) coupled with gas chromatography mass spectrometry (GC-MS) technology. The results showed 45 compounds were determined from Fuxing-Xueling *ginseng*, accounting for 87% peak area of the total peak area. The major components are furans (30%), acids (30%), aldehydes and ketones (12%). The method was applied to compare composition profiles of volatile and semi-volatile compounds of *ginseng* in different area of Changbai Mountain. Results of *ginseng* in differenet area of Changbai Mountain showed similar volatile and semi-volatile profile, but with different in amount. The GP-MSE sample preparation method has a well prospect of analyzing volatile and semi-volatile compounds in various plants and will facilitate the exploiting and utilizing precious medicinal plants of Changbai Mountain.

Key words: GP-MSE; Changbai Mountain; *ginseng*; volatile and semi-volatile compounds

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长白山不同区域人参中挥发性、半挥发性成分的研究

赵锦花, 杨翠, 王娟, 李东浩*

(延边大学长白山生物资源与功能分子教育部重点实验室, 吉林 延吉 133002)

摘要: 将气流吹扫微注射器萃取(GP-MSE)与气相色谱质谱(GC-MS)联用,建立了一种快速分析长白山人参中挥发性、半挥发性成分的方法. 在长白县人参中,共确定了 45 种化合物(占总组分含量的 87%),其中主要化合物有呋喃类(30%)、酸类(30%)和醛酮类(12%). 用该方法测定长白山不同区域人参中挥发性、半挥发性成分显示,不同区域人参中挥发性、半挥发性成分的组成相似,但含量有显著差异. 研究表明,GP-MSE 样品前处理方法对研究植物中挥发性、半挥发性成分有良好的应用前景,有助于植物资源的开发利用.

关键词: GP-MSE; 长白山; 人参; 挥发性、半挥发性化合物

0 Introduction

Ginseng is one of the most precious traditional Chinese medicinal perennial herb belonging to the genus *Panax* of *Araliaceae* family. Research has shown that *ginseng* benefits human health against various diseases, such as increasing resistance to physical, chemical and biological stresses[1]. It has been reported that *ginseng* contain properties like anti-aging, anti-diabetic, anti-carcinogenic, analgesic, anti-pyretic, anti-stress, anti-fatigue, has tranquilizing activities and promote DNA, RNA and protein synthesis activities. Besides, as a traditional medicine, *ginseng* was used in cancer patients[2-5].

Typical *ginseng* contain, *ginseng* oils and

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* **通信作者**: 李东浩(1965—),男,博士,教授,研究方向为有机分析、样品前处理技术开发.

sugars, organic acids, vitamins, amino acids and peptides. Among them, the main active non-volatile saponins. It is reported that plant volatiles play important role in biological signaling interaction. *Ginseng* also contains a wide range of chemical compound classes, such as hydrocarbons, alcohols, aldehydes, ketones, acids, esters and so on. Moreover, the semi-volatile components of *ginseng* root have reported containing a number of sequiterpenes[6], which prove that study on volatile and semi-volatile compounds in *ginseng* are vital. *Ginseng* matrix is very complex, and in analysis of volatile compounds, the isolation step is necessary before instrumental analysis. There are many sample preparation methods, such as Soxhlet extraction, microwave-assisted extraction, ultrasound-assisted extraction and supercritical extraction[7]. Recently, gas purge microsyringe extraction (GP-MSE) was developed by Yang and co-workers, the method is environmentally friendly and can simultaneously analysis volatile and semi-volatile compounds in various sample matrix within a short time (less than 5 min)[8-9]. In this study, a rapid analysis method was established to investigate the volatile and semi-volatile compounds in Changbai Mountain *ginseng* by gas purge microsyringe extraction (GP-MSE) coupled with gas chromatography mass spectrometry (GC-MS) technology.

1 Experimental

1.1 Chemical

Organic solvents (hexane) were HPLC grade obtained from Caledon (Georgetown, Ont., Canada).

1.2 Experiment

Ginseng sample was collected in different area of Changbai Mountain, namely Changbai, Erdaobaihe and Fusong county. All of the three *ginseng* samples were 4 years old. *Ginseng* samples were dried by VirTis-Freezer dryer (4 KBTXL), grinded and kept in −4 ℃ until analysis.

Extraction were done using GP-MSE. 5 mg *ginseng* sample were used with GP-MSE extraction time of 4 min; extraction temperature of 250 ℃; gas flow rate and condensing temperature were set to 2.0 mL/min and −4 ℃, respectively.

1.3 GC-MS analysis

Volatile and semi-volatile chemicals were analyzed using gas chromatography-mass spectrometry (GC/MS, GC-2010/QPMS-2010, Shimadzu) with DB-5MS capillary column (30 m, 0.25 mm ID, 0.25 μm film thickness, J & W Scientific, USA). Helium (>99.999% pure) was used as carrier gas with a flow rate of 1.0 mL·min^{-1}. The injector was set to 280 ℃ with splitless mode and the interface temperature was set to 280 ℃, the column temperature was maintained at 45 ℃ for 4 min and then programmed from 45 to 250 ℃ at 4 ℃/min, 250 to 280 ℃ at 6 ℃/min, then hold for 5 min. Qualitative and quantitative data of volatile and semi-volatile chemicals was obtained using scan mode, the scan range was m/z 45-450.

2 Results and conclusion

2.1 Volatile and semi-volatile constituents in *ginseng*

Based on the GP-MSE sample preparation method coupled with GC-MS, each peak was qualitative compared with mass spectrum database NIST11 (National Institute of Standards and Technology). Quantitative was evaluated by relative area. The results showed 45 compounds were determined from *ginseng*, accounting for 86% of the total peak area. Table 1 listed major volatile and semi-volatile compounds determined from *ginseng*. The few most abundant compound were 2-Furanmethanol (13.91%), Hexadecanoic acid (12.42%), cis-Linoleic acid (9.24%), and so on. In *ginseng*, the volatile and semi-volatile chemical species cover furans (30%), acids (30%), aldehydes and ketones (12%), esters (6%), alcohols (3%), phenols (3%), and other heterocyclic compounds (2%).

2.2 Comparison of volatile and semi-volatile constituents in different Changbai area *ginseng*

Generally, *ginseng*s are cultivated under shade for 4 to 6 years to yield high-quality *gin-*

seng with medicinal effects[10]. With the different cultivate area, the chemical constituents in *ginseng* could be different, GP-MSE-GC-MS method were applied to compare volatile and semi-volatile compounds of *ginseng* taken from Changbai, Erdaobaihe and Fusong county.

The typical gas chromatographic-mass spectrum chromatograms obtained from three different area *ginsengs* were shown in Fig. 1. Certain similarities and differences of compounds can be found from the chromatograms. Similarity of volatile compounds is higher than this obtained from semi-volatile compounds (shown in Fig. 1).

Table 1　Major volatile and semi-volatile compounds in *ginseng*

	Name	Formula	Molecular weight	Relative area/%
1	2-Furanmethanol	$C_5H_6O_2$	98	13.91
2	Hexadecanoic acid	$C_{16}H_{32}O_2$	256	12.42
3	cis-Linoleic acid	$C_{18}H_{32}O_2$	280	9.24
4	Artificial ant oil	$C_5H_4O_2$	96	6.47
5	1,2-Cyclopentanedione	$C_5H_6O_2$	98	4.92
6	2-Furancarboxaldehyde	$C_6H_6O_2$	110	4.88
7	cis-Oleic Acid	$C_{18}H_{34}O_2$	282	3.47
8	9,19-Cyclolanost-23-ene-3,25-diol, (3. beta. ,23E)-	$C_{30}H_{50}O_2$	442	2.60
9	beta. -Stigmasterol	$C_{29}H_{48}O$	412	2.19

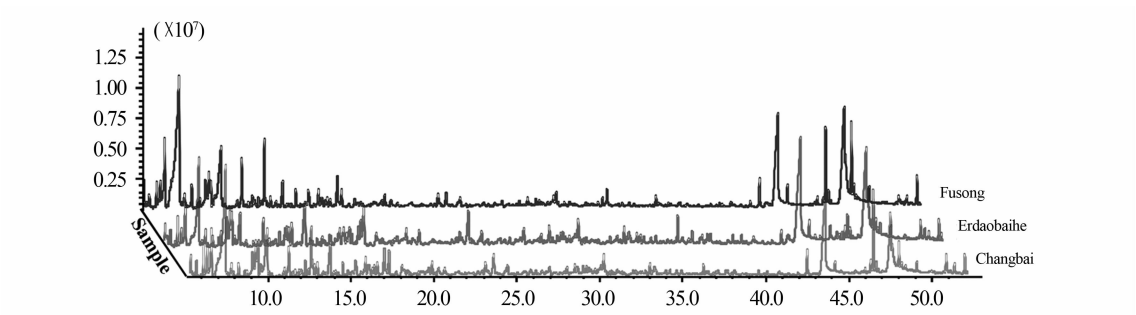

Fig. 1　Different volatile and semi-volatile compounds in *ginseng* from different Changbai Mountain area

Fig. 2 showed that there are significant differences in 15 selected compound of volatile and semi-volatile compound by comparing with amount (peak area).

As shown in Fig. 1 and Fig. 2, most of compounds are frequently found in different area of *ginseng*, while their contents are significantly different. Typical chemicals are Furfural, 2-Furanmethanol, 3-Methyl-1, 2-cyclopentanedione, 3-Ethyl-2-hydroxy-2-cyclopenten-1-one, Creosol, Palmitic acid, Linoleic acid and so on. Although these compounds were all found in *ginseng*, there are 2 to 3 times differences in amount. It has involvement with the different *ginseng* growth environment, such as soil moisture,

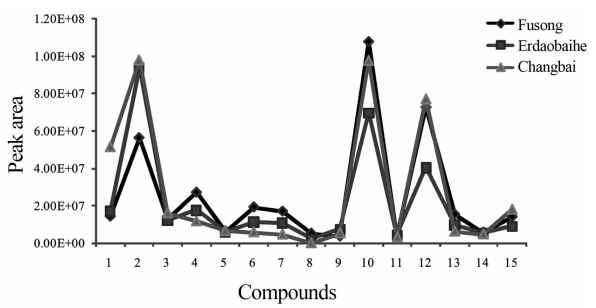

Fig. 2　Comparison of volatile and semi-volatile compounds in different Changbai Mount area (1. Furfural; 2. 2-Furanmethanol; 3. Acetylfuran; 4. 3-Methyl-1, 2-cyclopentanedione; 5. Furyl hydroxymethyl ketone; 6. 3-Ethyl-2-hydroxy-2-cyclopenten-1-one; 7. Creosol; 8. gamma-Muurolene; 9. n-Hexadecanoic acid methyl ester; 10. Palmitic acid; 11. n-Nonadecanol-1; 12. Linoleic acid; 13. Ethyl octadec-9,12-dienoate; 14. Behenic alcohol; 15. Stigmasterol.)

microorganism and so on. So, different growth environments will induce different production and accumulation mechanism of the chemicals in plant.

3 Conclusion

The gas purge microsyringe extraction coupled with GC/MS is a suitable analytical method for determination of volatile and semi-volatile chemicals in the *ginseng*. Results of the comparison study are indicated that differences of different area of *ginseng* are mainly originated from different content of the volatile and semi-volatile chemicals.

References:

[1] Lee H, Lee H, Yu H, et al. A comparison between high hydrostatic pressure extraction and heat extraction of ginsenosides from ginseng (Panax ginseng C. A. Meyer)[J]. J Sci Food Agric, 2011,91:1466-1473.

[2] Angelova N, Kong H, Van der H R, et al. Recent methodology in the phytochemical analysis of ginseng[J]. Phytochem Anal, 2008,19:2-16.

[3] Woo H, Shin B, Cho I, et al. Antiobesity effect of carbon dioxide supercritical fluid extracts of Panax ginseng C. A. Meyer[J]. J Korean Soc Appl Biol Chem, 2011,54:738-743.

[4] Chang Y, Seo E, Gyllenhaal C, et al. Panax ginseng: a role in cancer therapy? [J]. Integr Cancer Ther, 2003,2:13-33.

[5] Xie J, Zhou Y, Dey L, et al. *Ginseng* berry reduces blood glucose and body weight in db/db mice[J]. Phytomedicine, 2002,9:254-258.

[6] A M Abd El-Aty, Kim I, Kim M, et al. Determination of volatile organic compounds generated from fresh, white and red Panax ginseng (C. A. Meyer) using a direct sample injection technique [J]. Biomed Chromatogr, 2008,22:556-562.

[7] Sahena F, Zaidul I, Jinap S, et al. Application of supercritical CO_2 in lipid extraction: a review[J]. J Food Eng, 2009,95:240-253.

[8] Yang C, Wang J, Li D. Microextraction techniques for the determination of volatile and semivolatile organic compounds from plants: a review[J]. Anal Chim Acta, 2013,799:8-22.

[9] 杨翠,任春燕,李东浩,等. 气流式吹扫液相微萃取[J]. 延边大学学报:自然科学版,2011,37(2):111-114.

[10] Lee K, Kim G, Kim H Y, et al. Volatile compounds of C. A. Meyer cultured with different cultivation methods[J]. J Food Sci, 2012,77:C805-810.

科技信息

欧盟科技人员取得超低能耗技术突破

科技部门户网站报道(2014-02-27 日) 近期,由欧盟第七研发框架计划(FP7)提供资助、西班牙纳瓦拉大学(University of Navarre)领导的研发团队科技人员研究成功了能够在大自然的周围环境中(如来自光线、振动或温差的物理变化)获得能源供应的微芯片技术. 该无线传感器网络技术(WSN)主要由能够检测温度、声音、压力、振动和环境等的传感器网络节点和特制的超低能耗致动设备(如节能信号灯)组成. 这种节能信号灯的能源消耗仅相当于普通白炽灯泡的 5 000 万分之一. WSN 通过无线方式,将分布式自治感应器芯片和致动设备连接起来,并通过无线电波传输接入互联网.

微芯片的工作原理是利用一种新型的模拟转换器,从周围环境中获取必要的能源,尤其从检测对象中获取能源;因此,微芯片中的感应器装置无需蓄电池电源即可实现能源的完全自制. 该技术具有广阔的应用前景及潜力,目前研发团队新开发的铁路信号自治控制管理技术和环境检测技术已得到实际的商业化应用与验证.