Determination of volatiles released from plants by the self-made charcoal trap adsorption device coupled with gas chromatography-mass spectrometry

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Abstract The charcoal trap adsorption device was designed and used to adsorb the volatile organic compounds (VOCs) emitted from Ginkgo leaves and Lima beans. The adsorbed VOCs were determined using gas chromatography-mass spectrometry (GC-MS). Compared to solid phase microextraction (SPME), the self-made charcoal trap adsorption device was more advantageous to the enrichment of VOCs from Ginkgo leaves. Additionally, the quantitative analysis of the collected VOCs released from Lima beans was carried out through the addition of internal standard and the results of the two parallel experiments showed good repeatability. Because the eluent of the charcoal trap can be stored and used in the quantitative analysis as well as parallel experiments, the self-made charcoal trap adsorption device coupled with GC-MS is suitable for laboratory studies of plant volatile organic compounds.

Key words charcoal trap adsorption device; gas chromatography-mass spectrometry; GC-MS; volatile organic compounds; VOCs; Ginkgo leaves; Lima beans
1.2

![Structure of Ind-IleMe]

Fig. 2  Structure of Ind-IleMe

1.3

1.3.1  
6 mL 1 mmol/L Ind-IleMe 10 mL 10 mL 25 °C 4 000 lx 14 h 10 h 24 h 20 μL 10 μL 10 μL 40 μL 30 μL 10 μL 100 μmol/L 30 μmol/L 25 °C 1 h 2 μg 0.2 μg 4000 lx 24 h 50 μL 20 μL 20 μL 10 μL 100 μmol/L 100 μmol/L 10 °C/min 250 °C 1 min 10 °C/min 260 °C 3 min

1.4  
1.4.1  
Thermo TR-5MS 30 m × 0.25 mm × 0.25 μm 99.99% at 0 mL/min 1 μL 1 μL 40 °C 3 min/min 10 °C/min 260 °C 3 min

1.4.2  
EI 200 °C 70 eV
2.1 Carbon Trap Adsorption Device Assembly

The homemade carbon trap adsorption device mainly includes carbon trap adsorption column, carbon trap placement tube, intake tube, exhaust tube, air circulation pump and power adapter, etc. After placing the carbon trap adsorption column into the carbon trap placement tube, each part can be connected. Each connection has a thread, which can be tightened directly for use. The实物图见图1b.

The carbon trap adsorption column is mainly used to absorb and enrich the volatile substances released by plants, which can be regarded as an adsorbent extraction head. Its basic principle is to use the activated carbon in the adsorption column to absorb and enrich the volatile substances released by plants. Furthermore, due to the volatile substances released by plants are usually trace and even at the trace level, it is necessary to use a relatively sealed space to restrict the diffusion of plant volatile substances and increase their adsorption amount, so that even very little compounds can be collected, and at the same time, it can avoid the influence of external air pollutants. Therefore, in the experiment, choose a true vacuum dryer as the glass container for placing plants. The homemade carbon trap adsorption device has connected the air circulation pump, which can increase the gas disturbance and circulation in the experiment process, making the carbon trap adsorption become a cyclic and dynamic adsorption process, and thus avoid the accumulation of water vapor and temperature rise in the application; meanwhile, the use of the air circulation pump makes the gas containing volatile substances through the carbon trap adsorption column to circulate, which also greatly increases the adsorption efficiency of the carbon trap adsorption device, making the measurement results more accurately reflect the composition of plant volatile substances.

2.2 VOCS GC-MS

<table>
<thead>
<tr>
<th>Peak No. in Fig. 3</th>
<th>Compound tentative</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pinene</td>
<td>C_{10}H_{16}</td>
</tr>
<tr>
<td>2</td>
<td>farnesene</td>
<td>C_{15}H_{24}</td>
</tr>
<tr>
<td>3</td>
<td>caryophyllene</td>
<td>C_{15}H_{24}</td>
</tr>
<tr>
<td>4</td>
<td>copaene</td>
<td>C_{15}H_{24}</td>
</tr>
<tr>
<td>5</td>
<td>cadinene</td>
<td>C_{15}H_{24}</td>
</tr>
<tr>
<td>6</td>
<td>thujaopsene</td>
<td>C_{15}H_{24}</td>
</tr>
<tr>
<td>7</td>
<td>cedrene</td>
<td>C_{15}H_{24}</td>
</tr>
<tr>
<td>8</td>
<td>lannecy</td>
<td>C_{15}H_{24}O</td>
</tr>
</tbody>
</table>

2.3 VOCS SPME GC-MS

Fig. 3 Total ion current chromatograms of Ginkgo volatile compounds with two enrichment methods.

For peaks see Table 1.

Table 1 Main volatile compounds of Ginkgo leaves

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In the quantitative analysis, the amount of volatile substances adsorbed in the carbon trap adsorption column is calculated by the formula $W = \frac{A \times W_s}{A_s}$, where $A$ is the peak area of the substance, $A_s$ is the peak area of the internal standard, $W_s$ is the internal standard mass, and $W$ is the mass of the substance. The detection limit is 100 μmol/L.
量，重复性较好。

且可以进行多个样品的平行实验及植物

的质量，两组平行试验中，保留时间、峰面积及吸附

到的各化合物的质量重复性均较好。

参考文献:

本文设计组装了炭阱吸附装置。该装置与

联用适合用于实验室中活体植物

的定

现内标与各个挥发物校正因子的测定，因此，在计算

为内标溴代正癸烷的

为

的成分复杂，标准品不易得，很难实

(十六碳四烯烃)

(吲哚)

(十一碳三烯烃)

(芳樟醇)

(未知物)

(石竹烯)

(顺式茉莉酮)

(己烯基乙酸酯)

(戊烷基乙烯基甲醇)

(水杨酸甲酯)

(三烯八醇)

(邻氨基苯甲酸甲酯)

(未知物)

表

为内标溴代正癸烷的

表

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