Liquid Chromatographic Analysis of Carbonyl Compounds in Aerosols from High and Low Nicotine E-Cigarette Liquids Mirroring Realistic Puffing Topography

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Introduction

Tobacco smokers engage in more intensive puffing regimes (more frequent and longer puffs) when switching from higher to lower nicotine-containing cigarettes [1,2,3,4], this can result in increased toxicant exposure [5]. Such compensatory puffing behaviour has recently been demonstrated in experienced vapors using high and low nicotine concentration liquids in the lab [6]. Although exposure to toxins in e-cigarette aerosols is negligible by comparison with tobacco smoke [7], whether a more intensive puffing regime associated with using a lower nicotine concentration liquid increases exposure, has not been explored. This research is particularly timely with the recent introduction (20th May 2016) of the European Tobacco Product Directive (EU-TPD).

Aims

To establish whether more intensive puffing regimes associated with using a lower nicotine concentration produces higher levels of toxicants from e-cigarette nicotine aerosols.

Methodology

HPLC/diode array analysis was employed. Four carbonyl compounds formaldehyde, acetaldehyde, acrolein and acetone were quantified in liquid (vehicle of propylene glycol and vegetable glycerine 50/50%) and aerosol using 24 mg/mL and 6 mg/mL nicotine concentration liquids. Aerosols were generated by a smoking machine (figure 2; University of Technology, Lodz, Poland [8]) configured to exactly replicate puffing topography data obtained from a sample of 12 experienced vapors using both aforementioned solutions, for 1 h [6]. The ‘Joytech E'Vic Supreme’ e-cigarette (figure 1) (output voltage 3.9) was mounted with the Aspire Nautilus BVC tank (atomiser 1.8 Ohm). The 6 mg/mL liquid was used more intensively compared to the 24 mg/mL. Results are presented in number of puffs taken on average for 1 h of e-cigarette use (74 and 47 for 6 and 24 mg/mL liquids respectively as per the puffing topography in Dawkins et al, in press; table 1). Analyses was performed 6 times for each solution. T-tests were used for comparing the means in aerosols and in solutions.

Table 1. Puffing protocol used in the study

<table>
<thead>
<tr>
<th>Puff duration</th>
<th>Number of puffs</th>
<th>Intervals between puffs</th>
<th>Sampling time</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 mg/mL</td>
<td>3.76s.</td>
<td>14</td>
<td>74.5s.</td>
</tr>
<tr>
<td>6 mg/mL</td>
<td>5.04s.</td>
<td>14</td>
<td>44.3s.</td>
</tr>
</tbody>
</table>

Figure 1. E-cigarette and tank used in the study

| Table 2. Levels of carbonyl compounds found in liquids

<table>
<thead>
<tr>
<th>Levels (μg/50μl) in Liquids</th>
<th>Formaldehyde</th>
<th>Acetaldehyde</th>
<th>Acetone</th>
<th>Acrolein</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 mg/mL</td>
<td>N.D.</td>
<td>0.059 – 0.075</td>
<td>BLQ</td>
<td>N.D.</td>
</tr>
<tr>
<td>24 mg/mL</td>
<td>BLQ</td>
<td>0.043 – 0.067</td>
<td>0.080 – 0.094</td>
<td>N.D.</td>
</tr>
</tbody>
</table>

Figure 2. Smoking machine

Conclusions

The smoking machine, programmed with a more intensive puffing regimen to reflect compensation by experienced vapors on lower nicotine concentration liquid, resulted in higher aerosol levels of formaldehyde, acetaldehyde and acetone. Our findings suggest, vapors making a sudden switch to much lower nicotine concentration liquid (either due to the EU-TPD implementation or personal choice) may inadvertently increase their exposure to carbonyl compounds through compensatory puffing behaviour.

References