A comparison of mainstream marijuana and tobacco smoke

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Introduction

It is well known that smoking tobacco is a major health risk.

The Lancet Commission on pollution and health (2017)
Is smoking marijuana a health risk?

- ~200 million people smoke marijuana (vs 1.1 billion tobacco smokers)
- Canada has legalized recreational use and more countries are expected to follow
- Most marijuana consumption is by smoking (97% in Canada).
What are the physical and chemical properties of marijuana smoke? How do they compare to tobacco smoke?
Experimental set-up – Collecting the smoke samples

Cambustion Smoking Cycle Simulator (Health Canada Intense routine)

Filtered 3R4F reference cigarette
Or
Nonfiltered 0.5 g marijuana joint
Aerosol measurement

Measures:
- Mobility size distribution
- Aerodynamic size distribution
- Number/volume volatility fractions

Also, undiluted filter collection for:
- Total mass concentration and
- GC x GC-TOFMS analysis

Measures: Nonstripped effective density
Particle size

Nonstripped marijuana particles are almost 30% larger and slightly broader.

Aerodynamic Diameter

Mobility Diameter

Stripped

Upper limit of mobility measurement method

Stripped
Effective density

Nonstripped particles are spherical with density of $\sim 1000$ kg/m$^3$
Mass concentration

Mass concentration calculated with size distributions and effective density:

- Marijuana smoke had $2.5 \pm 0.7$ higher mass concentration

Total particle mass measured with filter (without dilution or ageing);

- Marijuana smoke had $3.4 \pm 0.6$ higher mass concentration

Note: Tobacco cigarettes were filtered, marijuana joints were not filtered
## Semi-volatile fractions

<table>
<thead>
<tr>
<th>Smoke from</th>
<th>Semi-volatile fractions (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Volume</td>
<td>Mass</td>
</tr>
<tr>
<td>Tobacco</td>
<td>7±6</td>
<td>98±27</td>
<td>97±33</td>
</tr>
<tr>
<td>Marijuana</td>
<td>17±8</td>
<td>98±23</td>
<td>97±32</td>
</tr>
</tbody>
</table>

Almost all smoke particles are mostly comprised of volatile material with a non-volatile residual.
Chemical Analysis – GC x GC - TOFMS

Tobacco

Triacetin

Nicotine

Monoterpenoids

Sesquiterpenoids
Chemical Analysis – GC x GC - TOFMS
Relative QUANTITIES of detected compounds
# Health effects for detected compounds

<table>
<thead>
<tr>
<th>Health Effect</th>
<th>Tobacco</th>
<th>Marijuana</th>
<th>Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 carcinogen*</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Group 2A carcinogen</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Group 2B carcinogen*</td>
<td>11</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Group 3 carcinogen</td>
<td>15</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Mutagen</td>
<td>70</td>
<td>50</td>
<td>28</td>
</tr>
<tr>
<td>Teratogen</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Toxic by other mechanisms</td>
<td>74</td>
<td>33</td>
<td>19</td>
</tr>
<tr>
<td>No risk data available**</td>
<td>497</td>
<td>426</td>
<td>162</td>
</tr>
<tr>
<td>Total detected by GC×GC-TOFMS</td>
<td>668</td>
<td>534</td>
<td>229</td>
</tr>
<tr>
<td>Total detected by both methods*</td>
<td>670</td>
<td>536</td>
<td>231</td>
</tr>
</tbody>
</table>

**Caveats:**
- Detection limited to ~C6 to C25 compounds
- Health effects analysis requires absolute quantification, dose, …
Conclusions

Similarities

• Particles are mostly semi-volatile with a small nonvolatile residual.
• Particles are spherical with effective density of $\sim 1000 \text{ kg/m}^3$
• Particles have dozens of carcinogenic and mutagenic compounds, many of which are in common.

Differences

• Marijuana particles are about $\sim 30\%$ larger
• Marijuana smoke has $\sim 3$ times higher mass concentration
Caveats

1) This study quantifies the physical differences (or similarities) between the smokes based on the sampling method used.
   • Variations are expected due to sampling/dilution conditions, smoking cycle, filters, etc.

2) This study only quantifies the relative difference in chemical composition

3) Tobacco smokers typically smoke much more than marijuana smokers (roughly speaking, ~400 cigarettes/month vs ~6 joints/months in Canada)
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