Qualitative Assessment of Flavor Ingredients in Market Electronic Nicotine Delivery Systems

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Abstract

As the use of electronic nicotine delivery systems (ENDS) grows, it may be useful to understand the types of flavor compounds that are being added as ingredients to the ENDS currently available on the market. A qualitative analysis of flavor compounds was performed using gas chromatography mass/spectrometry (GC/MS) on the aerosols from 5 market ENDS products. Two cig-a-like, one tank, and two pod mod closed products were assessed with tobacco, menthol, and fruit flavored cartridges. The flavor compounds identified were sorted into 11 chemical categories. The qualitative results showed that the majority of flavor compounds found in the tobacco flavored cartridges were organic acids (pungent, sour notes), phenolic compounds (smoky, sweet notes), and pyrazines/pyridines (nutty, earthy, cocoa notes). The menthol flavored cartridges primarily contained terpenoids (herbal, earthy notes) and menthol-related compounds. The most complex mixture of flavor compounds was found in the fruit flavored cartridges, with the majority being esters (aromatic, sweet notes), organic acids, and alcohols (sharp, grassy notes). Compounds identified in ENDS from all 11 chemical categories are also commonly present in traditional tobacco products. In general, these analyses revealed that similar types of flavor compounds are being used within the ENDS market.

Introduction & Methods

- Five closed ENDS products on the market were assessed for flavor ingredients
  - 2 Cig-a-likes
  - 1 Tank
  - 2 Pod Mods
- Three types of cartridges were assessed for each closed ENDS product
  - Tobacco flavored cartridges
  - Menthol flavored cartridges
  - Fruit flavored cartridges
- Aerosols were generated for flavor analysis
  - 100-200 puffs (400-500 mg)
  - 55 mL puff volume, 30 second puff interval, 3 second puff duration, square wave puff profile
  - Cerulean SM 450 Linear Smoke Machine
  - Cambridge pad extracted in impinger for whole aerosol sample collection
- Qualitative assessment of the flavor ingredients was performed using gas chromatography mass spectrometry (GC/MS)
  - DB-WaxEtr Column (30m x 0.25 mm i.d. x 0.25 mm film thickness)
  - Agilent 7890B-5977A GC-MSD
  - Scan 15-550 amu
  - Wiley 9th Library of Mass Spectra

Results

Flavor ingredient compounds were grouped into 11 chemical categories (see Table 1). Figures 1, 3, and 5 show the total ingredient breakdown by each chemical category for each of the 3 types of cartridges: Tobacco, Menthol, and Fruit flavored. Figures 2, 4, and 6 show similar breakdowns for each of the individual market products.

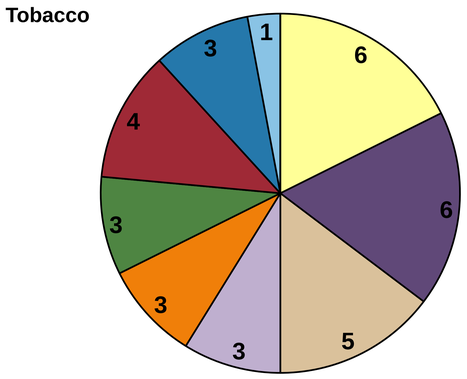

Figure 1. Flavor ingredients (34 total), broken down by chemical category, found in Tobacco flavored products

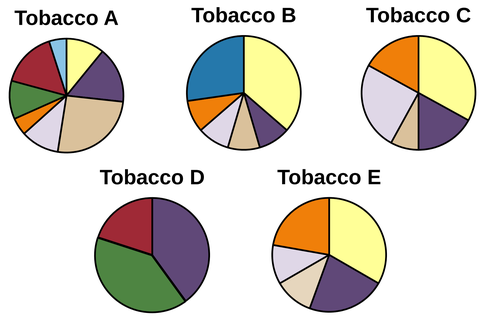

Figure 2. Flavor ingredients, broken down by chemical category, found in each Tobacco flavored product

Table 1. Flavor ingredients, broken down by chemical category

Chemical Category	#
Esters	20
Terpenoids	19
Menthol-Related	14
Alcohols	14
Organic Acids	9
Phenolics	9
Ketones	8
Lactones	6
Aldehydes	6
Pyrazines/Pyridines	6
Pyrones	4
Total Flavor Ingredients	**115**

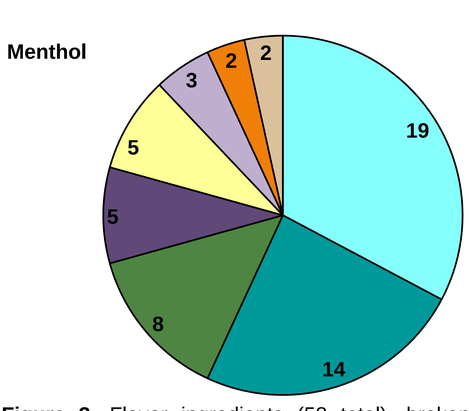

Figure 3. Flavor ingredients (58 total), broken down by chemical category, found in Menthol flavored products

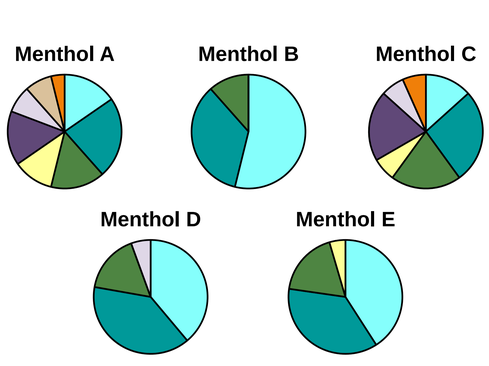

Figure 4. Flavor ingredients, broken down by chemical category, found in each Menthol flavored product

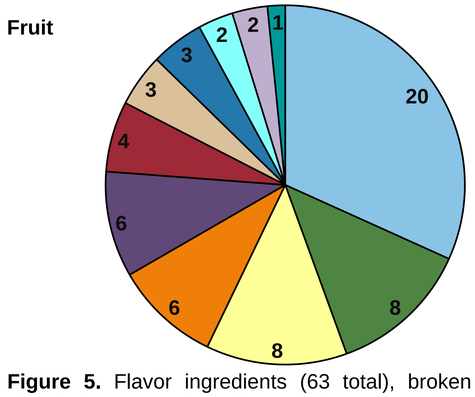

Figure 5. Flavor ingredients (63 total), broken down by chemical category, found in Fruit flavored products

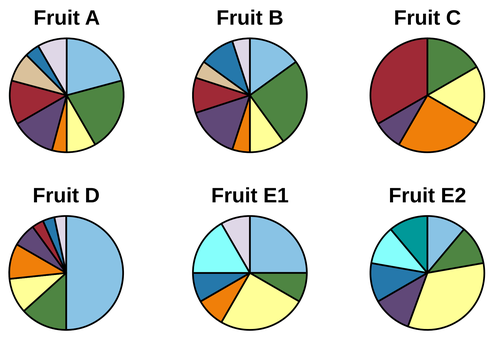

Figure 6. Flavor ingredients, broken down by chemical category, found in each Fruit flavored product

Discussion

- 115 total flavor ingredients were identified
- Tobacco flavored cartridges were dominated by
  - Organic acids (pungent, sour notes)
  - Phenolic compounds (smoky, sweet notes)
  - Pyrazines/pyridines (nutty, earthy, cocoa notes)
- Menthol flavored cartridges primarily contained
  - Terpenoids (herbal, earthy notes)
  - Menthol-related compounds
  - Alcohols (sharp, grassy notes)
- Fruit flavored cartridges involved a complex mixture of flavor compounds including
  - Esters (aromatic, sweet notes)
  - Organic acids (pungent, sour notes)
  - Alcohols (sharp, grassy notes)

Conclusions

- In general, similar types of flavor ingredients are being used within the ENDS market
  - 57 of 115 flavor ingredients were found in more than one ENDS product
  - The 2 most common flavor ingredients were each found in 10 of 16 ENDS products
  - On average, each product had 17 flavor ingredients, only 4 of which were unique to that product
- Compounds identified in ENDS are also commonly present in traditional tobacco products
  - Compounds from all 11 chemical categories are known to be found in tobacco and tobacco smoke†
  - 13 of the 20 most reported flavor ingredients in traditional tobacco products were also identified in ENDS††

† Rodgman, A., Perfetti, T.A. *The Chemical Components of Tobacco and Tobacco Smoke, 2nd Edition.* (2013). Boca Raton, FL: CRC Press.

†† Rossiter, L.M., Taylor, K.M. *Survey of Flavor Ingredient Use in Tobacco Products.* (2014, August). Poster session at the 248th American Chemical Society National Meeting, San Francisco, CA.