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## Brief report

# A Method for Classifying User-Reported Electronic Cigarette Liquid Flavors

Jessica M Yingst MS, Susan Veldheer MS, RD, Erin Hammett BS, Shari Hrabovsky MSN, Jonathan Foulds PhD

Department of Public Health Sciences, Penn State University College of Medicine, Hershey, PA

Corresponding Author: Jessica M. Yingst, MS, Department of Public Health Sciences, Penn State University College of Medicine, 500 University Dr, Room T3428, Mail Code: CH69, Hershey, PA 17033, USA. Telephone: 717-531-0003 ext. 289511; Fax: 717-531-0480; E-mail: [Jyingst@phs.psu.edu](mailto:Jyingst@phs.psu.edu)

## Abstract

**Background:** Along with the growth in popularity of electronic cigarette devices (e-cigs), the variety of e-cig liquids (e-liquid) available to users has also grown. Although some studies have published data about the use of flavored e-liquid, there is no standardized way to group flavors, making it difficult to interpret the data and replicate results across studies. The current study describes a method to classify user-reported e-liquid flavors and presents the resulting proportion of users in each flavor group in a large online survey of e-cig users.

**Methods:** Three thousand seven hundred sixteen participants completed an online survey about their e-cig use and responded to the following open-ended question regarding their use of e-liquid, "What is your favorite flavor and what brand of flavored liquid do you prefer?" Researchers used a 3 step method to determine the flavor attributes present in the e-liquids reported using an online search engine. Once all flavor attributes were identified, researchers used the constant comparative method to group the flavor attributes and delineate how to classify flavors with mixed components (eg, cinnamon Red Hots as a candy not a spice).

**Results:** The resulting classification scheme and proportions of e-liquids in each category were as follows: Tobacco (23.7%), Menthol/mint (14.8%), Fruit (20.3%), Dessert/sweets (20.7%), Alcohol (2.8%), Nuts/spices (2.0%), Candy (2.1%), Coffee/tea (4.3%), Beverage (3.1%), Unflavored (0.4%), and Don't Know/Other (5.8%).

**Conclusion:** To better understand the use of flavored e-liquids, standardized methods to classify the flavors could facilitate data interpretation and comparison across studies. This study proposes a method for classifying the characterizing flavors in e-liquids used most commonly by experienced e-cig users.

**Implications:** Current studies on the use of flavored e-liquid have used unclear methods to collect and report information on the use of flavors. This study adds a proposed method for classifying the flavors in the e-liquids used most commonly by experienced e-cig users. With a clear and explicit method for classifying self-reported flavors, future study results may be more easily compared.

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## Introduction

Electronic cigarettes (e-cigs) have become increasingly popular around the world<sup>1-3</sup>, particularly in the United States where more than 79% of US adults are currently aware of the devices and 3.7%

are using one on a regular basis.<sup>4</sup> As the popularity of these devices has increased, the types of devices and the associated products available to users have diversified,<sup>5,6</sup> making it difficult for users and non-users alike to understand the devices and their potential harms or benefits.

In an effort to manage the expanding and changing market for e-cigs, a deeming rule was finalized in 2016 in the United States that subjects e-cigs to Food and Drug Administration (FDA) regulation as a tobacco product, meaning that e-cigs and the associated products will be required to conform to product regulations determined by the US FDA.<sup>7</sup> One of the most discussed regulations for e-cigs is the use of characterizing flavors, such as fruit, candy, or clove, in the e-liquid.<sup>8,9</sup> Since the United States Family Smoking Prevention and Tobacco Control Act of 2009 removed characterizing flavors from cigarettes with the intention of reducing current smoking rates and halting youth initiation,<sup>10</sup> it is possible that the similar regulations could eventually apply to e-cigs.

E-cig flavoring is an important topic for youth e-cig and tobacco use research because flavors' play a role in increasing product appeal.<sup>8</sup> Similarly, adult e-cig users claim that flavor use affects their traditional smoking behaviors by encouraging cessation and preventing relapse.<sup>11,12</sup> It is important to understand the prevalence of different e-cig flavors used in these populations and the correlation of flavor use with e-cig and tobacco use behaviors and individual characteristics. This will help researchers to understand how flavors and flavor marketing affect e-cig and tobacco use behaviors. This can inform potential US FDA regulatory action made possible through the deeming rule as well as regulatory actions in other countries.

Despite the importance of this topic, collecting data on e-cig flavor use is very challenging for survey research, which usually relies on self-report. E-cig flavors are diverse and constantly changing and the name of the flavor might not reflect its taste. Existing surveys have taken many approaches to classifying flavors, but these approaches have weaknesses. One method used by large survey studies, like the Population Assessment of Tobacco and Health (PATH) Study,<sup>13</sup> the National Youth Tobacco Survey (NYTS),<sup>14</sup> and the International Tobacco Control Policy Evaluation Project (ITC survey),<sup>15</sup> ask participants to answer a yes/no question or choose what flavors they use from a list of predetermined options. PATH asks participants, "In the past 30 days, were any of the e-cigarettes/cartridges/liquids you used flavored to taste like menthol, mint, clove, spice, fruit, chocolate, alcoholic drinks, candy, or other sweets?" Participants responding yes were asked, "Which flavors have you used in the past 30 days? Choose all that apply."<sup>16,17</sup> Response options were "(1) Menthol or mint, (2) Clove or spice, (3) Fruit, (4) Chocolate, (5) An alcoholic drink (such as wine, cognac, margarita or other cocktails), (6) Candy or other sweets, and (7) Some other flavor." While this question allows the participant to choose all that apply, it leaves significant opportunity for misclassification of e-cig liquids that contain multiple flavors. For instance, using the PATH question, how might a participant code an e-cig liquid such as mint chocolate chip ice cream? Though the researcher may consider this particular flavor to be a "candy or other sweet," a respondent could also correctly choose "menthol or mint," "chocolate," or "some other flavor" depending on their interpretation.

A second method to classify e-liquid flavors is to allow the participants to report the brand and product name of their e-liquid using open-ended questions. The responses can then be classified by the researcher. This method is significantly more labor intensive, but it has the benefit of providing the researcher much more detail about the e-liquid with which to correctly classify the flavors. This method also removes error related to interpretation by the participant.

The current study employed the latter method to classify the e-liquid flavors reported in a large online survey study. Because of concerns related to youth initiation, this study suggests an important

purpose for classifying flavors is to understand not just the flavor attributes present in the e-liquid, but also how the e-liquid is marketed. For instance, an e-liquid may be flavored to taste like peach, a fruit, but it is marketed as peach rings, a candy and has a peachy taste more like the candy than the fruit. Because the e-liquid is depicted as a candy by the name or the description, it could be more appealing to youth, and thus should be classified as a candy, not a fruit. This study proposes a classification method to facilitate cross-survey and cross-jurisdictional surveillance and descriptive research. This study does not provide information on the chemical flavoring content or individuals' exposure, as flavoring and flavor marketing cannot provide information on the chemical content of the liquid. In addition, the study examines the proportion of e-cig users using each flavor based on the proposed methodology.

## Methods

### Participants

Participants completed an online survey about their e-cig use. Details about the survey can be found elsewhere.<sup>18,19</sup> Participants included in this analysis were current e-cig users at least 18 years of age who have used an e-cig at least 30 days in their lifetime. In addition, all participants were either current or former smokers. Participants were excluded from analysis if their preferred flavor, device type (first or advanced generation),<sup>18</sup> or the nicotine concentration of the liquid was not reported.

### Flavor Classification Method

#### Step 1—Identify Participant Response Type

All participants responded to the following question, "What is your favorite flavor and what brand of flavored liquid do you prefer?" The question was open-ended and participants could provide an answer in any format response they desired.

The first step taken to classify the participant responses to the above question was to group all responses into two categories, flavor name or product name, based on the response given by the participant. Responses considered flavor names were those where the participant named the flavor attribute in the e-liquid like fruit, cherry, vanilla, mint, or coffee and did not provide any brand information. Responses considered product names were those where the participant named a flavor by its brand's product name, such as "Ecto Plasma from Juicy Vapor" or "Papa Smurf from Flavorz by Joe."

#### Step 2—Identify Flavor Attributes In Each Response

The next step to classifying the e-liquids was to determine the flavor attributes present in each e-liquid. For participant responses identified as flavor names, no additional work was required to determine the flavor attributes because the flavor attributes were already listed in the participant response. For responses identified as product names, more work was needed to determine the flavor attributes in each e-liquid.

To determine the flavor attributes in each e-liquid flavor identified as a product name, the researchers performed an internet search. The response given by the participant was directly entered into the search engine (Google Chrome or Mozilla Firefox) and the search was started. If the participant provided the brand name and the product name given to the liquid by that brand, the brand website selling the liquid would be the number one search result. The researcher then entered that website to view the flavor attributes

of the given liquid, most often found in the description section for that e-liquid. For example, “Tribeca from Halo” was entered into Google Chrome and the first search result was the webpage selling the e-liquid, [www.halocigs.com](http://www.halocigs.com). The description for the e-liquid stated that the e-liquid has a smooth tobacco taste with slight vanilla and caramel undertones.

In some instances, the participant would provide only some information about the e-liquid, such as the product name. For example, the participant response “Dragon’s Blood” contained only the product name for the e-liquid given to it by its brand, but not the brand name. In cases like this, the participant response was entered into the search engine with the search term e-liquid appended to the end. Then, multiple search results were reviewed to determine the flavor attributes present in the e-liquid. In this case, the flavor attributes in “Dragon’s Blood” e-liquid were determined to be strawberry and cream.

In cases where not enough information was provided about the e-liquid, only the overall brand name was provided, or the online search did not yield definitive results, the flavor attribute could not be determined. Examples of participant response’s classified as undetermined were “mrb from dks,” “js2,” “fuzion vapor,” “custom DIY,” and “Royal Tread from local vendor.”

### Determining the Flavor Categories

Once all e-liquid flavor attributes were identified, researchers met to determine the most appropriate groupings using the constant comparative method.<sup>20</sup> The final classification scheme is as follows: tobacco, menthol/mint, fruit, dessert/sweets, alcohol, nuts/spices, candy, coffee/tea, other beverages, unflavored, and Don’t Know/Other. The tobacco category represented any e-liquid with pure tobacco flavor. The menthol category represented any liquid with a menthol, mint, or peppermint flavor attribute. The fruit category represented any liquid with a fruit flavor attribute including apple, strawberry, coconut, orange, or berries. The dessert/sweets category represents any e-liquid with flavors exclusive to desserts. This includes chocolate, vanilla, quick breads, cakes, waffles, donuts, cereals, and ice cream. The alcohol category represents any e-liquid that directly mimics the flavors of alcoholic drinks such as rum, absinthe, or absolute. The nuts/spices category represents e-liquids with flavors such as peanut butter, almond, cinnamon, and pecan. The candy category represents any e-liquid flavor that directly mimics a candy, such as licorice, sweetTARTS, gummy bears, or Swedish fish. All e-liquid mimicking drinks were classified into one of two categories. E-liquids representing hot drinks like coffee and tea were grouped while e-liquids representing cold non-alcoholic drinks were grouped. Common e-liquids in the coffee/tea group, in addition to coffees and teas, were “espresso” and “cappuccino”-like drinks. Common e-liquids in the beverage group were sodas, energy drinks, and lemonades. E-liquids reported to be unflavored were classified as unflavored. If the participant reported a liquid that had flavor attributes that did not fit into any of the above categories or the flavor attributes could not be identified from the response provided, the e-liquid was categorized as don’t know/other.

### Step 3—Apply Rules to Assign Each Liquid to a Flavor Group

Once the flavor categories were determined, the participant responses could be categorized. Since many e-liquids were comprised of multiple flavor attributes, strict rules had to be determined to consistently classify these e-liquids. In addition, we were interested in identifying complex marketing categories rather than simply flavor attributes so the rules were developed to be executed in an order that would

highlight the flavor as it was intended to be marketed. Therefore, the rules were developed as follows:

1. Any flavor added to tobacco or menthol was categorized as the added flavor.
  - For example, Tribeca from Halo contains tobacco, vanilla, and caramel flavors, so it was considered a Dessert/sweet flavor.
2. Any flavor with an alcohol product name or containing an alcoholic flavor attribute was classified as alcohol flavor.
  - For example, Pina Colada contains pineapple (fruit) and coconut (fruit) however the flavors were meant to mimic the alcoholic drink Pina Colada, so it was classified as alcohol flavor.
  - For example, Mad Murdock’s Radiator Fluid contains absinthe (alcohol) and citrus (fruit), so it was classified as alcohol flavor.
3. Any flavor with a drink product name or containing flavor attributes meant to mimic a drink were classified as a beverage flavor.
  - For example, Monster from Mt. Baker Vapor contains sweet, sour, and citrus (fruit) flavors meant to mimic the soft drink and were classified as a beverage flavor.
4. Any flavor that has a candy product name was classified as a candy flavor.
  - For example, Peppermint Patty contains chocolate (dessert/sweet) and peppermint (menthol/mint) and was classified as a candy flavor.
5. Any flavor with a dessert product name or containing dessert/sweet flavor attributes were classified as a dessert/sweet flavor.
  - For example, Apple Pie contains apple (fruit) but was classified as a dessert/sweet flavor because of the dessert name.
6. Any flavor with a fruit product name or containing a fruit flavor attributes were classified as a fruit flavor.
  - For example, Pure Michigan from Mister E-liquids contains apple (fruit) and strawberry (fruit) and was classified as a fruit flavor.

Executing the rules in the order specified above is important. For example, “Numbers from Seduce Juice” contains citrus and chocolate. Because the rule pertaining to dessert flavors should be executed prior to the rule pertaining to fruit flavors, this e-liquid should be classified as a dessert/sweet flavor.

The rationale for ordering the rules was based on several factors. First, the tobacco and menthol flavor rule were executed first so that flavors available in cigarettes, like tobacco and menthol, could be separated from flavors not available in cigarettes, like cherry or caramel flavoring. For example, a flavor containing cherry and tobacco should be classified as cherry and not tobacco. If the same regulations regarding flavors in cigarettes were applied to e-cigarettes, flavors with cherry would be banned, thus, it would be important to separate those flavors from those just containing tobacco. The later rules were ordered in a way so that flavors marketed and meant to mimic alcohol, candies, drinks, or desserts were classified as a whole, not by the components of the liquid. For example, although a flavor marketed as the alcoholic

drink absinthe may taste like citrus, it should be classified as an alcoholic drink, not a fruit, because it is marketed as an alcoholic drink flavor. A similar rationale applies to the candy group. Although the flavor in the e-liquid “peach rings” may be peach, the e-liquid is marketed as peach rings, a candy with a peachy taste, and the e-liquid should be classified as a candy. In addition, by implementing the rules in the order mentioned, it is possible to appropriately categorize e-liquids that have un-descriptive names (like Ninja Turtle or Fairy Tears) but are meant to mimic candy, alcohol flavors, etc. Because the marketing of product as well as the underlying flavor attributes are both important, the execution of the rules took both aspects into account.

## Data and Statistical Analysis

Study data were collected and managed using REDCap electronic data capture tools hosted at the Penn State Milton S. Hershey Medical Center and College of Medicine.<sup>21</sup> REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies. The statistical analysis was generated using SAS software, Version 9.3 (SAS Institute, Cary NC). Means and frequencies were calculated to describe the sample and the proportion of users using e-liquids in each flavor category.

## Results

The sample comprised 3716 participants. Participants had a mean age of 40.4 years, were 70.6% male, used an e-cig approximately 22.2 times per day, and have used an e-cig for 12.4 months on average. Most participants (75.4%) were using an advanced generation e-cig device and the mean nicotine concentration of the e-liquid used was 16.1 mg/mL. 18.5% of participants reported being a current cigarette smoker. Of the participants who reported being former smokers, 92.6% reported quitting smoking since initiating e-cig use.

Participant responses about their preferred e-liquid flavor ranged from “tobacco,” “light,” “menthol,” “cherry,” “apple pie,” and “cola” to “Kona cream from Vaperite,” “Tiger’s blood from Dura Smoke,” “Pluid by Mad Murdock,” “Zombie Apocalypse from Alice in Vapeland” and “Moo Juice from Mt. Baker Vapor”. **Table 1** displays examples of participant response’s and the assigned response category.

Almost a quarter of participants (23.7%) reported a preference for tobacco flavored e-liquid, followed by a dessert/sweets flavor (20.7%) and a fruit flavored e-liquid (20.3%). A small proportion of users reported a preference for menthol/mint flavor (14.8%). Only a few participants reported a preference for a beverage flavor (3.1%), an alcohol flavor (2.8%), a nuts/spices flavor (2.0%), a candy flavor (2.1%), or a coffee/tea flavor (4.3%). 0.4% reported a preference for unflavored liquid. 5.8% reported a preference for an e-liquid flavor that was classified as don’t know/other.

## Discussion

This study outlined a method for classifying the many e-liquid flavor options available to e-cig users, in the context of a self-report survey using open ended questions for users to identify their e-cig liquids. Compared to other studies, this study was one of the first to allow participants to openly report their flavor preference, without providing predetermined flavor group options. The current method allows the researcher to determine the flavor group to which each e-liquid belongs. This method is in contrast to the forced choice questions often used in large survey studies which leave the interpretation of the flavor groups and classification of the e-liquid up to the participant. A benefit of using the method presented in this study is that the researcher can choose to examine e-liquid flavors individually (eg, fruit, tobacco, and candy), or they can combine several flavor groups into one (eg, tobacco and menthol vs. all other flavors), based on the research question. Of particular value is the ability to compare

**Table 1.** Steps to Classifying E-Liquid Flavors

Participant response	Step 1—Classify as flavor or product name	Step 2—Determine the flavor attributes	Step 3—Assign to a flavor group
Alien vision “Boba’s Bounty”	Product name	Tobacco, chocolate, caramel, and vanilla	Dessert/sweet
Apple pie from The Vapor Room	Product name	Apple and pie	Dessert/sweet
Bear claw from velvet vapors	Product name	Cinnamon, almond, and pastry	Dessert/sweet
Black licorice	Flavor name	Licorice	Candy
Blue honey from vape dudes	Product name	Blueberry and honey	Fruit
Caramelized cappuccino	Flavor name	Caramel and cappuccino	Coffee/tea
Coffee	Flavor name	Coffee	Coffee/tea
DIY cola	Flavor name	Cola	Beverage
Fire and ice from vape dojo	Product name	Cinnamon and menthol	Nut/spice
Fruit flavors	Flavor name	Fruit	Fruit
Full flavor	Flavor name	Tobacco	Tobacco
Hazelnut	Flavor name	Hazelnut	Nut/spice
Johnson creek vanda	Product name	Vanilla custard	Dessert/sweet
Kringles curse from halo	Product Name	Peppermint	Menthol/mint
Mad murdock’s radiator pluid	Product name	Absinthe and citrus	Alcohol
Menthol	Flavor name	Menthol	Menthol/mint
Monster from Mt. Baker Vapor	Product name	Sweet, sour, and citrus	Beverage
Numbers from seduce juice	Product name	Citrus and chocolate	Dessert/sweet
Ninja turtle from OKC vapes	Product name	Smartees candy	Candy
Peppermint patty	Flavor name	Chocolate and peppermint	Candy
Pina colada	Flavor name	Coconut and pineapple	Alcohol
Pure Michigan from Mister e-liquids	Product name	Apple and strawberry	Fruit
Tribeca from Halo	Product name	Tobacco, vanilla, and caramel	Dessert/sweet



flavors available in cigarettes (tobacco and menthol) to ones that are not. This is not possible using the PATH question because the question asked includes menthol with the other characterizing flavors. Finally, it is important to note that this study evaluated and classified e-liquid flavors based on the respective marketing for the product, not on the chemical properties that make up the flavor attribute. Accounting for the marketing aspects of the e-liquid may facilitate exploration of the potential impact of availability of flavored e-liquid on youth initiation.

Based on our classification method, tobacco flavored e-liquids were most preferred, followed by dessert/sweet flavored and fruit flavored e-liquids. Currently, few studies have published data on flavor usage,<sup>22,23</sup> though the methods used to determine how the e-liquids were grouped was not clear, making comparison between studies impossible. One study did use a standard question on flavor usage that was developed by the PATH study, however, this study was in a youth population, also making comparison with our study difficult.<sup>17</sup> This study found that 63.3% of youth users preferred flavors other than tobacco, where the current study found 76.3% of adult users preferred non-tobacco flavors. The lack of studies on such an important regulatory topic shows that there is an absence of understanding about flavors and highlights the need for a clear method to start looking at flavors and their impact on initiation, use, and dependence.

Limitations of this survey study include that only self-reported answers on flavor preference could be collected. The chemical composition of the liquid was not obtained from the participants. Lab studies on the chemical composition of the flavored e-liquids could provide future insight into the ways to best classify flavored e-liquid based on the chemical components. In addition, talking with e-cig users about their perceptions of flavor groupings would be beneficial in determining consensus on this method.

As researchers work to inform regulators about use patterns and perceptions of modified risk tobacco products such as e-cigs, standardized methods for classifying e-liquid flavors should be employed so that data can be easily interpreted and compared across studies. This study is one of the first to offer a method for classifying the flavors in e-liquids based on the flavor attributes and marketing of the product.

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## Declaration of Interests

JF has done paid consulting for pharmaceutical companies involved in producing smoking cessation medications, including GSK, Pfizer, Novartis, J&J, and Cypress Bioscience.

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