

Novel Creation of a Rum Flavor Lexicon Through the Use of Web-Based Material

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Abstract: Flavor lexicons help both manufacturers and consumers communicate the intricacies of flavor nuances they experience within a product. Lexicon development typically requires the use of a trained sensory panel to evaluate a representative sample set of the product category to generate terms that describe certain product attributes. In the case of rum, there is considerable variation in terms of style, flavor characteristics, and the sheer number of rums produced making it difficult to create a lexicon in this manner. Furthermore, sensory fatigue from the high alcohol content can also hinder lexicon development. This is the first study to create a rum flavor lexicon using web-based material (comprising blogs, company descriptions, and review websites) to minimize the time and cost and to allow for the inclusion of a greater number of rum products. Reviews for over 1000 different rums were utilized, comprising evaluations that described an array of rums, including white, gold, aged, and agricole. Each evaluation was coded for aroma, aroma-by-mouth, and taste attributes using NVivo™ software to amass the sensory terms. Word frequency analysis was conducted on coded attributes. The analysis yielded 147 terms, sorted into 22 different categories. The most prominent terms included vanilla, oak, caramel, fruity, molasses, and baking spices.

Keywords: flavor, lexicon, rum, sensory, web-based material

Practical Application: Results of this study demonstrate that web-based material can be used for products containing a large variation and where significant sensory fatigue is an issue to create a lexicon provided enough evaluations of the product exist. The developed lexicon will aid in term generation for future descriptive analysis panels on rum, as well as provide a standardized language for use in the rum industry when training and evaluating samples for quality assurance as well as marketing.

Introduction

Flavor lexicons are standardized vocabularies that aid in the communication of the perceived sensory attributes in foods and beverages. An established vocabulary provides terminology to describe flavor perceptions in a consistent manner. Lexicons aid in communication between researchers, product developers and manufacturers for use in quality assurance and product assessment, as well as to aid marketers in articulating the subtle flavor perceptions to consumers. Lexicons typically contain terminology for multiple sensory perceptions encompassed in the term flavor, including aroma, aroma-by-mouth, taste, mouthfeel, and trigeminal sensations.

Lexicons have been developed for a variety of different food products including spices (Lawless and others 2012), cheese (Drake and others 2001), bread (Kleinert and others 2009), olive oil (Mojet and de Jong 1994), almonds (Civille and others 2010), tea (Koch and others 2012), and orange juice (Perez-Cacho and others 2008). Additionally, a number of lexicons have been developed for alcoholic beverages including beer (Clapperton and others 1976; Meilgaard and others 1979; Parker 2012), brandy (Jolly and Hattingh 2001), cognac (Lurton and others 2012), distilled beverages (Mc Donnell and others 2001), whisky (Piggott and Jardine 1979; Swan and others 1981; Lee and others 2001), and wine (Noble and others 1984, 1987). The wine flavor wheel

is one of the most well-known lexicons, recognized by connoisseurs and consumers alike. Standardized terms, definitions, and references for a product allow users to describe and verbalize the differences among products within a category (Lawless and Civille 2013).

Typical development of a lexicon requires the use of a trained sensory panel. Panelists generally undergo numerous hours of training on evaluating different food products through descriptive analysis (Lawless and Civille 2013). To develop a complete lexicon, samples that encompass all of the diverse aspects of a product category need to be evaluated. This can include not only products from different manufacturers but also products produced in various geographical regions or having different maturities to develop a comprehensive lexicon (Drake and others 2001). Once the products to be evaluated have been selected, panelists will generate terms to describe their perceptions, determine appropriate chemical or food product references, and develop specific definitions for each attribute. After the initial term generation, terms that are redundant are removed from the list. Once the terms and references have been determined, the lexicon will be organized into a comprehensive list. The developed lexicon can then be validated to demonstrate that the terms are effective for distinguishing relevant product characteristics within the category (Lawless and Civille 2013). Panelists start by scaling the attributes according to the selected references. Each sample is then evaluated by the panelists with each attribute being rated in comparison to its corresponding reference. The compiled data allow researchers to identify how products within the category differ from each other.

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Once a lexicon has been developed, it can be converted into a flavor wheel which provides a visual representation of the generated terms (Lawless and Civille 2013). Terms are typically grouped by category, with the grouping identified in the inner circle and the specific term listed along the outside. The completed wheel can be used to train new panelists by aiding with term selection and communication with other scientists, consumers, or marketers.

A limited number of sensory studies have been conducted on rum. A vocabulary for evaluating distilled spirits was developed using a white rum along with white tequila, vodka, gin, grappa, and pear acquavite (Mc Donnell and others 2001). Term development generated 100 initial terms which were then reduced to 30 final terms for use in qualitative descriptive analysis. De Souza and others (2006) used descriptive sensory analysis to compare the aroma profiles of cachaça and rum on the basis of 10 aroma attributes. Frantza and others (2016a, b) have recently published 2 papers where aroma profile analysis was used to compare model aroma recombinates to the original rum samples. These studies are limited in scope as they each evaluated only 1 or 2 rums, with a primary focus on the flavor chemistry of the products rather than on their sensory profiles. The most comprehensive sensory study on rum to date is a master's thesis by Gómez (2002) where 33 terms were generated through the evaluation of 15 different rums. However, this vocabulary is incomplete as demonstrated by their later descriptive analysis panel which utilized terms that were not part of the initial vocabulary (Gómez 2002). The main emphasis of these studies has been to develop terminology to aid in evaluating one or a specific subgroup of rum samples rather than to gain a comprehensive understanding of rum flavor across the entire category.

Currently, there is no published flavor lexicon for rum. Rum is an extremely complex product category due to its limited standards of identity. The only production requirement is that the distillate must be produced from a sugarcane by-product (Labeling and advertising of distilled spirits, 27 C.F.R. § 5.22 1969). Since rum can be produced from a variety of sugarcane products, be distilled in multiple ways, and aged in any type of barrel the manufacturer desires, there is a significant amount of variation amongst products classified as rum. Rums are typically grouped into several categories including white, gold, aged, agricole, flavored and spiced rums (Ayala 2001). White rums are typically aged in either stainless steel tanks or wood casks for 1 to 2 y and then filtered through charcoal. Gold rums are typically aged for 1 to 3 y in wood casks. Aged rums are those that have been aged for at least 3 y or more. Agricole rums are produced from pure sugar cane juice rather than molasses and are produced predominately in the French West Indies. Flavored and spiced rums are rums blended with fruits and spices during production and should not be compared with rums produced in the traditional manner. Due to the enormous variation in the product category and the sensory fatigue panelists would experience from the high alcohol content of the product, a rum lexicon developed in the traditional way would be both expensive and time intensive.

Web-based materials are increasingly available, with more content being added to the internet on a daily basis. The ease of access allows enthusiasts and connoisseurs of spirits and alcoholic beverages, such as rum, to publish their opinions and reviews online. Additionally, companies readily market their product through the use of descriptive terminology. Compiling the terms already being used by consumers and the rum industry provides an excellent

starting point for the creation of a flavor lexicon. A similar approach has recently been used to create a flavor wheel for Chenin Blanc wine, where the researchers used the terminology found in the John Platter wine guide to construct the wheel (Valente 2016).

With this in mind, the objective of this study was to evaluate a new method for lexicon creation of rum through the use of web-based materials. Rum products have numerous product descriptions and reviews available online. Use of web-based material allowed for the collection of data on a wide variety of rum products, more than could feasibly be evaluated with traditional methods.

Materials and Methods

Selection of web-based material

Web-based material consisting of blogs, company descriptions and review websites, were chosen based on the following criteria: use of qualitative flavor descriptors and website organization. Web-material was found through the use of Google™ search using keywords such as “rum blogs” and “rum reviews.” Blogs and websites that provided only reviews and/or ratings for rums but no qualitative flavor descriptions were excluded from the study. Company web pages were sought for each rum reviewed on other websites. All companies that had web pages and product descriptions were included. Seventeen websites and 57 company descriptions were selected for analysis (Table 1). Only reviews available through June 2015 were included. All evaluations were captured as PDFs and imported into NVivo™ (NVivo qualitative data analysis software; QSR International Pty Ltd. Version 10, 2014).

Evaluation of web-based material for sensory terms

Each rum evaluation was coded by hand for aroma (orthonasal perception), aroma-by-mouth (retronasal perception), and taste (consisting of basic tastes, mouthfeel and trigeminal) attributes. Only qualitative descriptors were coded. Subjective descriptors such as good, bad, excellent, and mature were excluded. Once all evaluations were coded, word frequency analysis was conducted in NVivo on the collected attributes. Any descriptor that appeared at least 10 times throughout the entire dataset was selected for the preliminary lexicon. This was a natural cutoff in the data as there were still sensory relevant terms and each term encompassed 0.05% of the total terms coded.

Categorization of flavor terms

A sorting exercise was performed to categorize the terms. Ten individuals, 3 male, and 7 female, 23 to 29 y of age were selected from University of Illinois students based on availability and interest in participating on the sorting panel. Each person was given a bag containing all of the selected terms written on paper slips. Participants were instructed to sort the terms into categories as they saw fit, based solely on their knowledge of the presented terms. Panelists were allowed to ask for definitions of terms they did not know. They were also instructed to group redundant terms and remove terms they felt were coded by mistake or not relevant to flavor perceptions such as palate, little, slightly, and sip. Once the participants had sorted all of the terms, they were asked to label and write a brief description for each category they constructed. The data were visually analyzed by the panel facilitator who compiled the categories developed from panelists into 1 comprehensive lexicon. Terms that were grouped together consistently by multiple assessors were placed together in the final lexicon. Terms that were sorted into multiple categories by panelists with no clear majority

Table 1—Web-based material used to create the rum flavor lexicon.

Name of blog	Type	Website address
Best of Luxury	Blog	http://www.bestofluxury.com/rankings-of-best-rum-liquors
Bilgemunky	Blog	http://www.bilgemunky.com/category/pirate-reviews/rum/
Dowd's Tasting Notes	Blog	http://dowdtastingnotes.blogspot.com/
El Machete's Rum Reviews	Blog	http://macheterum.blogspot.com/
Fahrenheit 173	Blog	http://fahrenheit173.com/ratings/rum/?search=&top=all&origin=all&type=w
Got Rum	Blog	http://www.gotrum.com/rumreviews
Proof 66	Blog	http://www.proof66.com/liquor/rum.html
Refined Vices Blog	Blog	https://refinedvices.com/rum-reviews/
Rob's Rum Guide	Blog	http://www.robsum.com/
Rum Dood	Blog	http://rumdood.com/rum-reviews/
Rum Ratings	Blog	https://www.rumratings.com/brands
Scottes' Rum Pages	Blog	https://scottesrum.com/category/all-rum-reviews/
Spirits Review	Blog	http://spiritsreview.com/class/rum/
Tastings	Blog	http://www.tastings.com/Home.aspx
The Rum Howler	Blog	https://therumhowlerblog.com/rum-reviews/
The Rum Shop	Blog	http://www.rumshop.net/
The Rumelier	Blog	http://www.therumelier.com/index.html
Admiral Rodney	Company	http://www.saintluciarums.com/admiral-rodney.html
A.H. Riise	Company	https://www.ahriiserum.com/products.html
Amrut	Company	http://www.amrutdistilleries.com/validated/pages/opdr.html
Angostura	Company	http://www.angostura.com/Brands/
Antigua Distillery Cavalier	Company	http://www.antiguadistillery.com/our-range.html
Appleton Estate	Company	http://www.appletonestate.com/en/our-rum/
Atlantico	Company	http://www.atlanticorum.com/services3
Bacardi	Company	https://www3.bacardi.com/us/en/our-rums/
Ron Barcelo	Company	http://www.ronbarcelo.com/initial.html
Brugal	Company	https://www.brugal-rum.com/our-rum/
Cana Brava	Company	http://www.canabravarum.com/
Clarke's Court	Company	http://www.clarkescourtrum.com/products/aged
Rhum Clement	Company	http://rhumclementusa.com/index.php
Chairman's	Company	http://www.saintluciarums.com/chairmans-reserve.html
Cockspur	Company	http://www.cockspurrum.com/concoctions/
Cruzan	Company	http://www.cruzanrum.com/rum-collection/
Deadhead	Company	http://deadheadrum.com/the-rum.html
Dictador	Company	http://www.dictador.com/dictador-rums.html
Diplomatico	Company	http://www.rondiplomatico.com/rums
Don Pancho Origenes	Company	http://origenesdonpancho.com/?age-verified=cd956f803a
Don Papa	Company	http://www.donpaparum.com/the-goods.html
Dos Maderas	Company	http://www.rondosmaderas.com/en/index.php
El Dorado	Company	http://theeldoradorum.com/our-portfolio
Facundo	Company	http://www.facundorum.com/the-rum-collection/
Flor de Cana	Company	http://flordecana.com/eng/products
Gosling's	Company	http://www.goslingsrum.com/our-products/
Green Island	Company	http://greenislandrum.com/products.html
Havana Club	Company	http://havana-club.com/en/cuban-rum/havana-club-rum
Kirk and Sweeney	Company	http://www.3badge.com/kirkandsweeney/
Koloa	Company	http://koloarum.com/rums/
Montanya	Company	http://www.montanyarum.com/home-rums/
Mount Gay	Company	http://www.mountgayrum.com/
Neisson	Company	http://www.neisson.fr/-rubrique14-.html?lang=en
New Grove	Company	http://www.newgrove.mu/#
Newfoundland Screech	Company	http://screechrum.com/#products
Ophimus	Company	http://spiritimportsinc.com/brands/opthimus/
Penny Blue	Company	http://indianoceanrum.com/pennybluerum/
Plantation	Company	http://www.plantationrum.com/rums-plantation#vintages
Rhum Agricole Bologne	Company	http://www.rhumbologne.fr/en/rums.html
Rhum Barbancourt	Company	http://barbancourtrhum.com/the-rhums/
Rhum J.M	Company	http://www.rhumjmusa.com/index.php
Ron Abuelo	Company	http://www.ronabuelopanama.com/category/brand/?lang=en&lang=en
Ron Matusalem	Company	http://www.matusalem.com/en.html
Rum Nation	Company	http://www.rumnation.com/en/
Saint James	Company	http://www.saintjames-rum.com/#!/gamme
Santa Teresa	Company	https://ronsantateresa.com/us/#/we-make-rum
Sergeant Classick	Company	http://sgtclassick.com/default.asp
St. Barth	Company	http://www.rhumstbarth.com/collection-rhum.asp
Tanduay	Company	http://tanduay.com/brands/tanduay-rhum-5-years/
The Real McCoy	Company	http://www.realmccoyspirits.com/therum
TOZ	Company	http://www.saintluciarums.com/toz.html
Trois Rivières	Company	http://www.plantationtroisrivieres.com/3-rivieres/the-collection/id/1319
Wild Geese	Company	http://thewildgeeseecollection.com/rum/our-rum/
Yacuro	Company	http://www.calderonglobaltrade.com/en/ron_yacuro/

Table 2—Categorization of terms generated from web-material used to create the flavor wheel.

First tier	Second tier	First tier	Second tier	First tier	Second tier
Sugar	Candied	Woody	Barrel	Citrus	Lemon
	Honey		Cedar		Lime
	Honeycomb		Oak		Marmalade
	Maple		Sandalwood		Orange
	Marshmallow				
	Marzipan	Nutty	Almond	Alcoholic	Arrack
	Molasses		Hazelnut		Bourbon
	Nougat		Pecan		Brandy
	Sugarcane		Walnut		Cognac
	Syrup				Sherry
Caramel	Treacle	Leather	Saddle		Whiskey
					Wine
	Brown	Earthy	Cigar	Medicinal	Alkali
	Butterscotch		Musty		Copper
	Caramelized		Peat		Metallic
	Cola		Root		Mineral
	Crème Brulee		Sap		Rubber
	Praline		Tobacco		Tar
	Toffee				
		Vegetal	Floral	Tastes	Bitter
	Buttery		Fresh		Salty
Dairy	Cream		Grass		Sweet
	Custard		Green		
			Herbal		
Chocolate	Cocoa	Fruity	Minty	Mouthfeel	Astringent
	Fudge		Tea		Buttery
Coffee	Mocha		Apple		Creamy
			Apricot		Crisp
Confections	Fruitcake		Cherry		Dry
	Gingerbread		Currants		Heavy
	Meringue		Dates		Oily
Baking Spices			Figs	Trigeminal	Rough
	Allspice		Grapes		Sharpness
	Cardamom		Peaches		Silky
	Cinnamon		Pear		Smooth
	Clove	Dried Fruit			Supple
	Ginger		Dried Apricot		Syrupy
	Licorice		Dried Dates		Thick
	Mace		Dried Currants		Velvety
	Nutmeg		Dried Figs		
	Peppery		Prunes		Bite
	Vanilla		Raisin		Burn
Roasted	Burnt	Tropical Fruit	Banana		Harsh
	Charred		Coconut		Hot
	Smoky		Mango		Pungent
	Toasted		Pineapple		Sharp
					Warm
					Tannins

were placed into their final grouping based on the organization of previous alcoholic beverage flavor wheels (Noble and others 1984, 1987; Jolly and Hattingh 2001; Lee and others 2001).

Results and Discussion

Rum reviews from 17 different websites as well as product descriptions from 57 different companies were compiled for data analysis. Over 3000 individual reviews were coded for 1053 different products which encompassed white, gold, aged, and agricole rums. Flavored and spiced rums were not included in this analysis as additional flavoring agents are added to these products to change the flavor of the rum. Initially, 267 individual terms were selected through the word frequency analysis. The 10 most frequently used terms to describe rum flavor were vanilla, sweet, spices, oak, caramel, fruity, dry, smooth, sugar, and molasses. These 10 words comprised 28.48% of the total descriptors coded.

The selected terms were given to participants for categorization. Through this exercise, a number of terms were eliminated from the lexicon as they were either duplicate words that had multiple spellings or endings such as fruit, fruits, and fruity or words that were not useful attribute descriptors such as deep and tones. Terms which could be considered compound terms, or terms composed of multiple attributes, were not eliminated from the lexicon. The individual categorizations were then combined based on how often terms were grouped together. After term categorization, a final lexicon consisting of 147 terms sorted into 22 categories was created (Table 2). Descriptors were not identified as positive or negative with regard to overall flavor quality. All terms remained as they appeared in the web-based material with the exception of brine which was replaced with salty for the lexicon. The final lexicon is a compilation of the most prevalent terms currently used to describe rum flavor. It is expected that only a subset of these terms would be required to describe an individual rum.

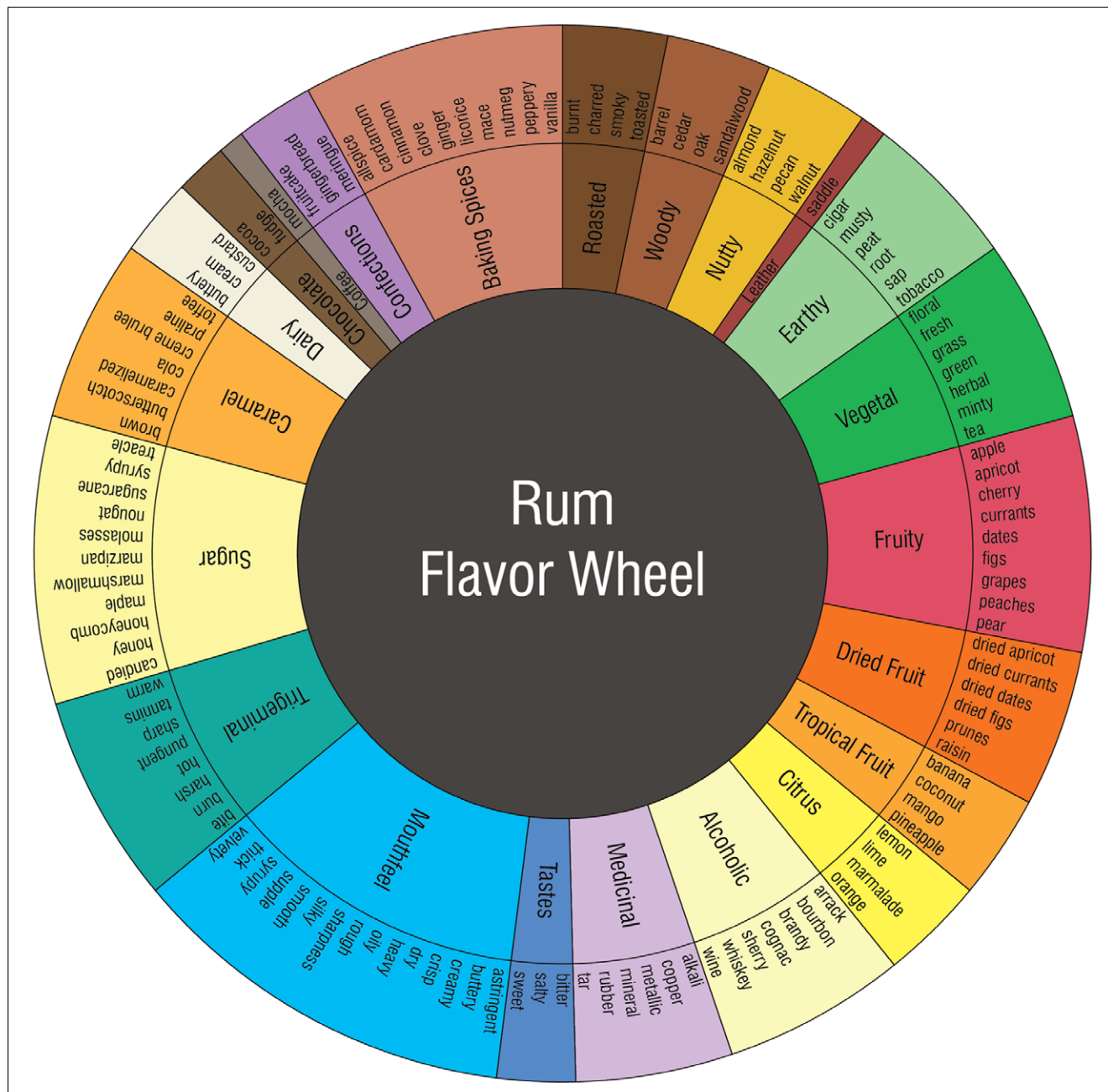


Figure 1—Rum flavor wheel developed from web-based material describing white, gold and aged rums.

Rum flavor wheel

The terms selected for the lexicon were organized into a flavor wheel for ease of use (Figure 1). The rum flavor wheel is split into 2 tiers, with 22 first tier descriptors and 125 second-tier descriptors. The innermost tier consists of the broader terms, while the outer wheel contains more precise terminology within each inner category. Terms that are more similar are located closer to each other on the wheel.

All of the first tier descriptors have been used in other alcoholic beverage lexicons as category groupings except for chocolate, coffee and confections (Clapperton and others 1976; Meilgaard and others 1979; Shortreed 1979; Noble and others 1984, 1987; Langstaff and Lewis 1993; Jolly and Hattingh 2001; Lee and others 2001; Le Barbe 2003; Lurton and others 2012). Terms associated with sugary products are typically categorized as

sweet-associated rather than categorized under sugar as we have done (Shortreed 1979; Jolly and Hattingh 2001; Lee and others 2001; Le Barbe 2003). All of the categories have been used in at least 2 other lexicons except alcoholic beverages and dairy products. The whisky flavor wheel published by Lee and others (2001) is the only lexicon to include other alcoholic beverages as a category which they label "previous use." Additionally, mouthfeel and trigeminal sensations tend to be grouped together when found on previous flavor wheels (Clapperton and others 1976; Meilgaard and others 1979; Shortreed 1979; Noble and others 1984, 1987; Langstaff and Lewis 1993; Jolly and Hattingh 2001; Lee and others 2001; Le Barbe 2003; Lurton and others 2012). Meanwhile, chocolate and coffee terms have not previously been used as a category, although they are found as second tier terms (Clapperton and others 1976; Noble and others 1984, 1987; Jolly & Hattingh

2001; Le Barbe 2003; Lurton and others 2012). Chocolate has previously been grouped under caramel, smoky, sweet associated and vanilla, while coffee has been grouped under caramel, smoky, toasted, and woody.

Terms most common to rum categories

The abundance of data collected using web-based material allows for the identification of not only the terms used to describe rum as an entire class but also demonstrates how the various categories of rum differ from each other. Rums categorized as white, gold, and a variety of age statement types including 2 to 5 y, 5 to 10 y, 10 to 20 y, and 20+ y were able to be analyzed. The 15 most prevalent aroma and aroma-by-mouth terms in each categorization can be found in Table 3. These data indicate that all rums appear to be characterized by vanilla, caramel, fruity, and spices. White rums seem to be further characterized by coconut, floral, banana, and mineral notes compared to the other categories; whereas, woody, tobacco, toffee, and chocolate notes seem to increase as a function of age. Previous sensory profiles of rums also show the terms vanilla, caramel, fruity and terms related to spices as key attributes to describe rum flavor along with alcoholic/ethanolic and woody (Gómez 2002; De Souza and others 2006; Franitza and others 2016a, b). Previous studies have not focused on aroma differences as a result of maturation, making this the first study to provide insight into how rum aroma profiles may change as a result of maturation.

Discussion of the rum lexicon

The use of web-based material for term generation provides an excellent starting point for lexicon development. The final lexicon contains many terms that overlap with already published lexicons for alcoholic beverages. All of the category descriptors except trigeminal, chocolate, leather, dairy, and coffee as well as more than half the individual terms have been used in previous lexicons for alcoholic beverages (Piggott and Jardine 1979; Swan and others 1981; Noble and others 1984; Jolly and Hattingh 2001; Lee and others 2001; Mc Donnell and others 2001; Schmelzle 2009). The substantial overlap of terminology indicates that appropriate descriptors were coded for and used to develop the wheel. The terms not previously used in flavor lexicons are likely to be descriptors that are unique to rum.

A similar data mining approach has recently been used to construct a flavor wheel for Chenin Blanc wines (Valente 2016). The researchers collected terms from the John Platter Wine Guide over a 7-y period. The guide annually rates the wines produced by the vineyards in South Africa, enabling them to amass terms from 2746 wines. Our approach is similar in that both studies are collecting potential terms from previously published reviews. Our study further expands the use of data mining, as we have evaluated reviews from multiple online sources rather than just a single publication. Both studies demonstrate that preexisting data can be used to construct a valid flavor lexicon.

While the current practice for lexicon development makes use of a descriptive analysis panel, original flavor wheels for beverages such as wine and beer were developed through the use of experts in the field who suggested terms to be included in the lexicon (Clapperton and others 1976; Noble and others 1987). This collaboration led to the creation of lexicons which adequately described the beverage class. A similar approach was followed here, where reviews from rum experts, enthusiasts, and connoisseurs were collected and evaluated to create the lexicon. While the

reviewers did not specifically propose terms, we used their descriptors in the development of the rum lexicon.

A limiting factor of the lexicon is that web-reviewers do not adequately define the terms they use in their descriptions. As a result, no precise definitions or references for terms were collected to create this lexicon. While definitions are helpful for a better grasp of the accurate perception of an attribute, many flavor wheels do not contain definitions for their terms. This is true for many whisky wheels (Jackson 1989; MacLean 1997) as well as the McCormick Spice Wheel (Lawless and others 2012). While definitions are helpful, they are not essential for the wheel to be useful. Many times panelists identify that a sample contains a familiar attribute but are not able to articulate what they perceive without the visual cue to accompany the perception. Having a lexicon accessible to them gives panelists a selection of words to choose from, instead of forcing them to generate the term from memory. Additionally, a majority of the terms included in the rum lexicon have inherent meanings for panelists such as the aroma of caramel, clove or banana.

While definitions are not always a necessity for connoisseurs or expert judges, they are essential if the terms are to be used as part of a descriptive analysis panel. Definitions, as well as specific references, will need to be developed and selected in order for a panel to consistently rate the terms across samples. Defining terms through the use of a descriptive analysis panel would be beneficial to clarify the meaning of the terms with respect to how they are perceived in rum. This would be especially useful for the trigeminal and mouthfeel terms, as people tend to be less familiar with those sensations compared to terms which describe food products.

Another limiting factor of the rum lexicon is the use of compound terms. During typical lexicon development, panelists are discouraged from using terms that combine multiple attributes and prompted to break those terms apart into singular attributes. However, this is not the case for web reviewers, they describe what they perceive, and sometimes the attributes are combined to form a complex term that is more easily identifiable than the individual attributes. For example, our wheel contains the term mocha which combines the aromas of chocolate and coffee, and even those attributes could be considered compound terms as well. Praline is another compound term of nutty and caramel. Additional compound terms encompassed in the rum lexicon include marzipan, crème brûlée, tea, cigar, fruitcake, and gingerbread. Regardless, compound terms have been used in other lexicons as well. Most notably, coffee and tea are typically included in lexicons (Noble and others 1984, 1987; Jolly and Hattingh 2001; Lee and others 2001; Le Barbe 2003; Lurton and others 2012) even though entire lexicons have been created to characterize those products (Seo and others 2009; Koch and others 2012; Muller and Joubert 2013; Theron and others 2014; Spencer and others 2016). These terms are most likely included in lexicons as they are easy for evaluators to identify since the combination of aromas has a characteristic profile that people encounter on a regular basis. The terms marzipan and cigar (box) have been included in the whisky (Lee and others 2001) and cognac (Lurton and others 2012) flavor wheels, respectively. Additionally, the whisky (Lee and others 2001), sparkling wine (Le Barbe 2003), and brandy (Jolly and Hattingh 2001) flavor lexicons include alcoholic beverages such as sherry and port as attributes.

It should be noted that to the best of our knowledge this is the first attempt to create a flavor lexicon for rum. Even though over 3000 reviews were utilized for this analysis, it is expected that the

Table 3—Top 15 flavor descriptors for each category of rum.

White	Gold	2 to 5 y	5 to 10 y	10 to 20 y	20+ y
Vanilla	Vanilla	Spices	Vanilla	Vanilla	Vanilla
Banana	Spices	Vanilla	Oak	Oak	Spices
Citrus	Sugar	Caramel	Caramel	Spices	Oak
Caramel	Caramel	Oak	Spices	Caramel	Fruity
Fruity	Oak	Fruity	Fruity	Fruity	Caramel
Coconut	Fruity	Molasses	Sugar	Molasses	Orange
Oak	Molasses	Sugar	Molasses	Toffee	Sugar
Spices	Banana	Tobacco	Cinnamon	Sugar	Toffee
Molasses	Toffee	Orange	Tobacco	Orange	Woody
Sugar	Woody	Toffee	Toffee	Tobacco	Molasses
Butterscotch	Nutty	Banana	Orange	Cinnamon	Cinnamon
Cream	Tobacco	Coconut	Butterscotch	Woody	Tobacco
Floral	Orange	Cinnamon	Leather	Banana	Chocolate
Mineral	Honey	Butterscotch	Banana	Chocolate	Honey

lexicon will need to be modified over time, similar to the case for the wine and beer lexicons and most recently the coffee lexicon (Meilgaard and others 1979; Noble and others 1987; Spencer and others 2016). The beer terminology wheel was altered after discussions at the annual meetings of the European and American brewing societies (Meilgaard and others 1979). Participants were able to submit suggestions by mail in order to refine the lexicon to better meet the practical needs of brewers' societies (Meilgaard and others 1979). The wine aroma wheel also allowed for feedback from experts in the field leading to the addition of several terms, reorganization of the wheel, and the addition of chemical or food references for each term (Noble and others 1987). The new coffee wheel utilized industry experts to develop the lexicon terms, followed by statistical analysis of term sorting (Spencer and others 2016). These modifications have allowed the lexicons to change to be better aligned with the needs of these ever-changing industries.

Conclusion

While the rum wheel includes terms utilized by companies and avid spirit enthusiasts, it is likely that there are missing terms that may be identified by a trained panel. Validation of the wheel using a descriptive analysis panel would be a first step in the refinement process. Additionally, this wheel only includes terms which describe the finished rum products. The wheel would likely need to be expanded if it were to be used during the production process.

The developed rum flavor lexicon provides manufacturers and retailers with an initial vocabulary to describe rums. This will allow the same perceptions to be communicated consistently and provide terminology for attributes that people may not have been able to previously articulate. The next step would be to define the different terms using a descriptive analysis panel so that each term has a standard reference and definition that can then be used to train new people for quality assurance. This rum lexicon will be used to aid in the development of terms for a descriptive analysis panel by providing a bank of terms for the panel to assess when generating terms.

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Author Contributions

C. Ickes collected and analyzed the test data and drafted the manuscript. Authors K. Cadwallader and S. Lee provided technical oversight of the project and contributed to the writing and editing of the manuscript.

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