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Effective Communication of Cider Sensory Quality: A White Paper

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1.0 Executive Summary

Cider, the alcoholic beverage made from fermented apple juice, is becoming a widely popular, value-added beverage. Though cider consumption and production overall is increasing in the US, it is critical to communicate the value and quality of cider clearly and effectively so that consumers and other professionals understand what sets different cider products apart. Because flavor is a driving force behind consumer liking and acceptability of cider, accurately conveying the sensory quality of individual cider products is important for guiding consumers to make mindful, satisfying consumption and purchase decisions. Accurately and effectively conveying the sensory quality of cider is also important for quality control standards as the cider industry moves forward.

The purpose of this white paper is to convey findings of a large Hard Cider Sensory Project conducted from 2020-2022, with realistic applications for how best to communicate the sensory quality of cider. Recommendations made in this white paper are based on the most current research in the field initiated by researchers at Virginia Tech and Cornell University. These sensory-focused research projects were funded by the United States Department of Agriculture (USDA) and the National Institute of Food and Agriculture (NIFA) to support growth of the hard cider industry particularly in the Northeast and Mid-Atlantic United States. Recommendations in this paper are based on four main research studies:

- *Task 1:* Explore consumer preferences and perceptions of what defines a “good” cider and cider-drinking experience using focus groups with regular cider consumers
- *Task 2:* Validate the Merlyn Dryness Scale; a method based on using a cider’s chemistry to predict its resulting sensory perception of dryness and sweetness
- *Task 3:* Investigate the sensory attributes that can be used to describe and differentiate cider products within the current US cider market using sensory descriptive analysis
- *Task 4:* Construct a cider flavor wheel using a comprehensive list of sensory terms grounded in prior cider sensory research and validated by cider industry professionals

For *Task 1*, focus groups were organized, conducted, and analyzed by researchers at Virginia Tech. In total, 14 focus groups were conducted with 99 cider consumers across Virginia, Vermont, and New York. Focus groups were conducted using standard methods common in qualitative research. Sessions were audio-recorded and analyzed using reflexive thematic analysis to generate broad, overarching themes about cider preferences. From this research, consumers reported reasons for drinking cider that were related to: perceived diminished health effects, flavor preferences, the drinking occasion, product information, price and packaging, regionality.

For *Task 2*, the Merlyn Dryness Scale was validated using three (3) commercially available cider products. The recommended chemical tests were conducted on all three cider samples, and the samples were served to 48 untrained sensory panelists (regular consumers) at two different serving temperatures (chilled and room temperature). During the sensory portion of the research study, panelists were also asked to rate their liking of the cider samples as well as check descriptive sensory terms which they believed best described each cider sample. From this research, it was determined that the Merlyn Dryness Scale is not an effective tool for describing the sensory dryness and sweetness of cider products. Rather, descriptive language and residual sugar content are more clear indicators of sensory dryness and sweetness.

For *Task 3*, a classical sensory descriptive analysis study was conducted with 8 trained panelists and 42 cider products from Virginia, Vermont, and New York. Panelists were trained to taste, describe, and evaluate the cider products with definitive reference standards using the consensus method. Panelists then blind evaluated all 42 cider products rating the intensity of all agreed upon sensory descriptors. This study generated 29 sensory terms which were significant for distinguishing the cider samples, and this study provided preliminary evidence of sensory differences in cider related to stylistic differences, geographic origin, and packaging.

For *Task 4*, all sensory descriptors from cider sensory studies conducted on US cider products between 2020 and 2022 were compiled into a terminology word bank. Cider professionals then sorted these sensory terms into groups based on their conceptual similarity. From these sensory clusters, researchers developed a flavor wheel for describing hard cider.

Based on the results of these individual projects, researchers were able to generate the following recommendations for communicating cider quality effectively:

1. Use clear, descriptive sensory terms that (1) can be easily understood by consumers, (2) is honest and transparent, (3) have been previously confirmed to distinguish between cider products
2. Exercise “new,” non-research supported sensory terms (1) that have easily understood definitions and (2) with as many consumers and other stakeholders as possible who are external to your business
3. Employ descriptive sensory terms that move beyond sweetness and dryness, emphasize acidity and mouthfeel, and communicate basic information about cider chemistry
4. Consider incorporating information, content, or marketing that makes simple recommendations for what types of products are best consumed at certain types of drinking occasions
5. Be thoughtful, intentional, and inclusive when describing cider production and processing information

These recommendations are further elaborated upon below, with specific examples from the individual research projects and their respective findings.

2.0 Introduction

In the past twenty years, cider production and consumption have increased substantially. In the US, there are three major apple-growing and cider-producing regions – The Northern Midwest, the Pacific Northwest, and the Northeast. These three regions are different in various aspects: including the types of apples being grown, the scale of apple agriculture, and the concentration of cider producers, and more. From a historical perspective, apple agriculture and cider production has strong roots in the Northeast, where cider production was immensely popular in colonial times. This white paper intends to communicate the findings and applicable results of research conducted on the Northeast and Mid-Atlantic US cider industry, particularly in New York, Virginia, and Vermont. These three states rank 1st, 8th, and 12th respectively as states with the most cideries, and the Lake Champlain Watershed, Hudson Valley, Finger Lakes, and Shenandoah Valley regions all have supported active orchards and rich cider-making cultures for centuries. These three states of the Northeast and Mid-Atlantic are an integral piece of the current cider marketplace.

With cider's increasing popularity, the industry has faced many challenges. Consumer preferences are shifting following the patterns of the craft beer and alternative beverage sectors. Within the cider industry, product standards have been described as inconsistent and unclear because cider is often closely equated to wine and beer, yielding a sensory identity that is not well established or unique. Different types of cider are often marketed very similarly, even if the products are noticeably different. In particular, the cider industry faces continued challenges related to describing the dryness and sweetness of individual cider products, and moving beyond the use of terms like “dry” and “sweet” to describe and differentiate the sensory experience that cider can offer. Because of these inconsistencies and challenges, the American Cider Association (ACA) and other cider stakeholder organizations urge the need for a clearer and more reliable template for describing cider, especially cider flavor.

To better understand cider sensory quality and the current state of the US cider industry, researchers at Virginia Tech and Cornell University aimed to answer the following broad research questions:

- What defines a good cider and the cider-drinking experience?
- What descriptive language can be used to describe and distinguish cider products?
- How is cider quality and value currently communicated in the cider marketplace?

From these research questions, researchers employed both traditional and innovative methods within the sensory science field to understand the cider consumption experience and communication about the cider-drinking experience. The field of sensory science aims to evoke, measure, analyze, and interpret responses before, during, and after consumption as perceived through the senses of sight, smell, touch, taste, and hearing (H. T. Lawless & Heymann, 2010c). Over the past century, standardized principles and practices have been developed and confirmed to provide structure and control for understanding the sensory quality of specific foods. Sensory science often assumes that a large sample of consumers or “taste-testers” should have enough diversity in their sensory perceiving abilities and sensory preferences to represent themes that apply to the broader population. Sensory science also uses humans as analytical instruments that can be trained to perceive certain attributes or qualities in a consistent, reliable fashion in order to discern concrete sensory differences amongst a selection of products.

In addition, the sensory experience as a whole is highly contextual (Betancur et al., 2020; Kim et al., 2016; Lahne et al., 2014; Meiselman, 2019; Nijman et al., 2019), meaning that the liking of and sensory

perception of products is not solely based on intrinsic qualities alone. Environmental cues, such as the music that is playing and product information, can heavily influence the judgment and perception of a product (H. T. Lawless & Heymann, 2010a; Meiselman, 2019) – so, it is important to understand these factors when understanding the overall sensory quality of a product such as hard cider.

As with many other foods and beverages, tastes, aromas, and mouthfeels are key components of the cider sensory experience. Cider aromas or smells can vary and impact the perception of sweetness. Polyphenols, including tannins, are compounds in apple skins that can transfer into apple juice and cider, and which impart a drying or “waxy” sensation on the surface linings of the mouth. Tannins can impact the perception of sweetness, sourness, bitterness, and astringency (Lea & Arnold, 1978; Symoneaux et al., 2014, 2015). With cider, it is believed that products can be judged on overall flavor, aromas, and mouthfeels, or products can be judged based on the presence or absence of individual, specific attributes such as berry-like, fruity, fresh apple flavors, as well as woody, earthy, and musty flavors (Phetxumphou et al., 2020). Often, the sensory attributes that are described as “bad,” “faulted”, or “off” in the context of wine can be described similarly in the context of cider, due in part to the similar fermentation methods.

The following sections of this white paper provide a detailed description of all four sensory projects that were conducted for the Hard Cider Sensory Project by researchers at Virginia Tech and Cornell University, with support from the USDA and cider industry stakeholders. This research was primarily conducted in the Northeast and Mid-Atlantic US, specifically in Virginia, Vermont, and New York, to serve as a “snap-shot” of the US cider industry. Following a detailed account of the sensory projects, recommendations are discussed with references to the individual projects and project results.

3.0 Task 1 – Consumer Focus Groups

Task 1 consisted of consumer focus group research which was conducted in order to gain a holistic understanding of consumer perceptions and preferences regarding hard cider. Qualitative focus groups are tools used in the fields of sociology and anthropology to study human experiences. Focus groups allow researchers to understand how and why consumers, in particular, experience specific products and what factors influence consumers' perspectives. More and more, focus group research is becoming common in the sensory science field as a tool to openly explore consumers' sensory experiences. Focus groups for sensory science also allow researchers to better understand how environmental factors (e.g., music or product information) influence consumption patterns and taste perception.

The work and findings of *Task 1* were published in (journal to be determined) in (date to be determined) under the title: "*Appeal of the Apple: Exploring consumer perceptions of hard cider in the Northeast and Mid-Atlantic United States.*" The following sections provide an overview of the work and key findings from this research.

3.1 Methods

For formal data collection described in *Task 1*, focus group sessions were conducted at cideries, specialty food and beverage shops, and at university settings throughout Virginia, Vermont, and New York from April - August 2021. Focus group participants were recruited through university and cidery listservs and social media sites, local grocery stores, and word-of-mouth in local communities. All participants were self-reported regular cider consumers, and the majority of focus group sessions occurred in normal cider-drinking settings. During each focus group session, participants openly discussed their answers to questions such as "What is your favorite cider and why?" and "When do you like to drink cider?" Participants engaged in discussion with each other based on their preferences and opinions of the cider industry. During the sessions, participants were also given three (3) ciders to taste, which stimulated discussion about what they like and dislike relative to the cider samples. These methods are common for focus group research that is used to explore sensory-oriented preferences.

All focus group sessions were audio-recorded and transcribed by the researcher who moderated all sessions, and resulting transcripts were analyzed using reflexive thematic analysis. Reflexive thematic analysis is a commonly used and reliable method of exploring and tracking patterns and themes across what people say in audio-recorded transcripts. With this tool, researchers were able to identify consistent themes relative to what participants liked and disliked in cider and how they viewed the cider-drinking experience.

3.2 Results

In total, 99 consumers (52 female; 39 male) participated in 14 focus groups (5 in Virginia, 3 in Vermont, 6 in New York). The number of participants per focus group ranged from 4 to 10 and sessions lasted 50-75 minutes. Six primary themes summarized the majority of consumers' perspectives about cider. First, many consumers reported an initial interest and desire for cider because of its perceived diminished health effects. Many consumers believed cider to be less filling and bloating compared to beer, and less intoxicating compared to wine. Consumers were also driven to drink cider because they liked the overall taste of cider more compared to other alcoholic beverage options. Consumers had diverse individual flavor preferences; with some liking extreme dryness and others liking a subtle sweetness. Many consumers enjoyed funkiness and tartness or acidity out of the desire to taste something unique that they have never experienced before in other beverages. However, extreme funkiness, acidity, and other bad aromas (such as sulfuric smells) were identified consistently as signs of poor quality. Consumers also had split opinions on how "apple-y" a cider should be, and most consumers enjoyed ciders flavored with adjuncts, particularly those that contain regional plants, herbs or seasonal fruits.

Consumers reported that their flavor preferences and definitions of quality with cider were heavily influenced by the drinking occasion. Occasions such as summer-related activities, outdoor activities, or large social gatherings were more conducive to crisp, refreshing, subtle-y-sweet cider with minimal complexity or funkiness. Occasions that involve food-pairing or which offer an environment conducive to reflecting on a cider's complexity and production background were more conducive to traditional, "wine-style" cider. With these observations related to the drinking occasion, it is believed that many diverse and distinct cider products can coexist in the marketplace in order to satisfy a diversity of tastes and drinking occasions.

Consumers were also interested in how cider was made and where a cider and its raw material came from, including information about apple varieties, fermentation methods, aging time, history, and other related topics. Consumers had a strong preference for locally-made products because they valued knowing that their purchases were supporting regional agriculture and communities. They also preferred products made at a small scale, or more specialty products, because they appreciated how these types of products seemed to come from an identifiable person that presumably put in an intentional amount of care and craftsmanship.

Lastly, consumers' opinions of cider were heavily influenced by regional customs. Consumers felt that being in a heavy cider-producing region, such as the Northeast, heavily motivated them to drink cider in the first place. Consumers in common wine-producing regions were also more inclined to drink wine-style or bottled (i.e., 750 mL format) cider products, and were more accustomed to spending more money on cider. Because cider was a regional agricultural staple, drinking cider made consumers feel connected to their local community and they liked the community-oriented appeal of cideries – even if those cideries were not directly based out of an orchard but were rather surrounded by a generally abundant apple-growing region (e.g., Rochester, NY).

4.0 Task 2 – Validating the Merlyn Dryness Scale

Task 2 involved a validation of the Merlyn Dryness Scale procedures for predicting cider sensory dryness and sweetness based on cider chemistry. The Merlyn Dryness Scale is a four-unit scale and math-based model for determining a cider’s dryness or sweetness based on the cider’s chemistry. This scale was developed by New York Cider Association stakeholders with the goal of improving consistency in cider dryness and sweetness communication, for all cider products in the marketplace. The scale was closely adapted from the International Riesling Foundation’s scale for describing the sensory dryness and sweetness of Riesling wine, also based on wine chemistry. The units of the scale include the terms “dry” (from 0-1), “semi-dry” (from 1-2), “semi-sweet” (from 2-3), and “sweet” (from 3-4), as seen in Figure 1.



Figure 1. Merlyn Dryness Scale as developed by the New York Cider Association.

To determine a cider product’s place on the scale (i.e., its dryness or sweetness), the residual sugar content (grams/Liter) is divided by the total titratable acidity (grams/Liter), and the resulting ratio is adjusted based on polyphenol content. If the polyphenol content of a cider is <500 ppm, the ratio is unadjusted on the line scale; if the polyphenol content is 500 to 750 ppm, the ratio is reduced by $\frac{1}{4}$ unit on the scale; if polyphenol content is 750 to 1000 ppm, the ratio is reduced by $\frac{1}{2}$ unit; and if the polyphenol content is >1000 ppm, the ratio is reduced by $\frac{3}{4}$ unit on the scale.

The work and findings of *Task 2* were published in the *Journal of the American Society of Brewing Chemists* in October 2022 under the title: “*Can Cider Chemistry Predict Sensory Dryness? Benchmarking the Merlyn Dryness Scale.*” The following sections provide an overview of the work and key findings from this research.

4.1 Methods

Validating the Merlyn Dryness Scale was accomplished by first measuring the appropriate cider chemical parameters of three (3) commercially available cider products. Residual sugar (i.e., fructose and glucose) content was measured using an enzymatic kit from Megazyme. Titratable acidity was expressed in malic acid because that is the dominant acid in apples and hard cider. Polyphenol content was measured using the Folin-Ciocalteu (F-C) method as recommended by the developers of the Merlyn Dryness Scale.

Following chemical analyses, the same three (3) commercially available cider products were exposed to 48 regular cider consumers, who were asked to rate the dryness and sweetness of each sample on the original four-unit Merlyn Dryness Scale. These consumers were also asked to rate their liking of the cider samples and to check sensory attributes that they believed matched each cider product (i.e., a “Check-all-that-apply” sensory task). In addition, all three of the original cider samples were served at two different serving temperatures to evaluate the effect of serving temperature on sweetness and dryness perception – so all consumers evaluated six (6) cider samples in total.

4.2 Results

Results of the chemical procedures indicated that all three cider samples should be plotted beyond 4.00 on the Merlyn Dryness Scale, or that they should be classified as “very sweet.” Average dryness-sweetness ratings for the three ciders based on the sensory evaluations ranged from 1.81 to 2.16, which are extremely different from the chemistry-based ratings that exceed 4.00. These results alone suggest that the Merlyn Dryness Scale procedures and scale is not an effective tool alone for describing the sensory dryness or sweetness of cider products. Also, serving temperature did not have statistically significant effects on consumers’ sensory dryness and sweetness ratings. Results of the word-checking activity, where consumers checked sensory attributes that best matched each product, showed preliminary evidence that certain descriptive terms are used more often alongside the word “dry”, and that other terms are used more often alongside the word “sweet.” Altogether, this research showed that descriptive terms and residual sugar content alone are potentially relevant predictors of whether consumers describe a cider as dry or sweet.

5.0 Task 3 – Sensory Descriptive Analysis

Task 3 utilized sensory Descriptive Analysis (DA) to construct a sensory lexicon for describing the sensory quality of hard cider products and for differentiating cider products made and sold in Virginia, Vermont, and New York. Descriptive analysis is a type of sensory evaluation testing that involves training a panel of people to taste and evaluate specific descriptive features within a product space. With this type of testing, panelists taste many different products and generate a large word bank of terms that can be used to describe those products. Then, panelists blind evaluate products by rating the intensity of each term in the large word bank, for each product being tested. The end goal of descriptive analysis is to determine which sensory descriptive terms are the most important for describing and distinguishing products according to trained tasters.

The work and findings of *Task 3* were published in the *Journal of Food Science* in March 2023 under the title: “*Sensory descriptive analysis of hard ciders from the Northeast and Mid-Atlantic United States.*” The following sections provide an overview of the work and key findings from this research.

5.1 Methods

To conduct a descriptive analysis study with hard cider products, 42 ciders were chosen at random from a list of all cider products made in Virginia, Vermont, and New York. Eight (8) panelists trained for a total of 13 hours, tasting and discussing the sensory features of all 42 cider products. During these tasting discussions, the panelists refined and finalized a list of 33 descriptors that could be used to describe the 42 products. After their training, the panelists evaluated all 42 cider products two times and rated the intensity of all 33 descriptors for each product evaluation. Products were served blind – panelists could not see the packaging or color of the product, and they did not know anything about the product.

5.2 Results

Results of the panelists sample evaluations confirmed that 29 of the 33 sensory terms were the most important for describing and differentiating the cider products. In other words, the 42 ciders could be described consistently using those 29 terms, and the panelists were consistent in rating some descriptors as higher or lower in intensity for specific products. Many of the terms generated in this descriptive study were comparable to those generated in previous sensory studies on hard cider. Results of this research also offered preliminary evidence of differences in sensory quality that are related to cider style, geographic origin, and packaging format.

6.0 Task 4 – Validating a Cider Flavor Wheel

Task 4 involved the comprehensive development of a flavor wheel for describing hard cider. Flavor wheels are used extensively in the food and beverage industry as both marketing, training, and quality assurance tools. Flavor wheels are often generated manually with the support of multivariate statistical techniques by either researchers or industry leaders, and flavor wheel development is often based heavily on descriptive sensory testing (see Section 5). New methods exist for generating flavor wheels that rely more on the objective similarity of sensory terms and less on the subjective semantic word associations of researchers. In this research project, a no-taste, free word-sorting task was completed with consumers and cider industry professionals in order to assess the word sorting patterns of each group of stakeholders. From the word sorting task, results were used to construct a flavor wheel for describing hard cider sensory quality.

The work and findings of Task 4 were published in _____ in _____ under the title: “*Validating a Hard Cider Flavor Wheel Using Free Word Sorting and Multivariate Statistical Techniques.*” The following sections provide an overview of the work and key findings from this research.

6.1 Methods

For this research project, an initial list of over 150 sensory terms was compiled from five previous descriptive sensory studies on hard cider made in the US. From this extensive list of terms, researchers reduced terms that were vague or referred to other alcoholic beverages (e.g., “characterless”, “wine-like”, “heavy”, “sticky”), resulting in a final flavor word bank of 73 descriptive terms. Following this initial step, called “lexicon generation”, 58 cider consumers and 40 cider industry professionals independently sorted all 73 sensory terms into groups based on the perceived similarity of terms. From this word sorting task, results were analyzed using advanced multivariate statistical techniques enabling researchers to subsequently and seamlessly develop a flavor wheel for US hard cider.

6.2 Results

Results of the word sorting task revealed that consumers and cider industry professionals do not have significantly different word associations and word sorting patterns. This proposes evidence that one flavor wheel could be easily understood and used by both sets of cider industry stakeholders, regardless of their level of cider expertise and sensory experience. The final flavor wheel developed by researchers is organized based on the word sorting patterns revealed by both consumers and industry professionals, and is shown in *Figure 2*.

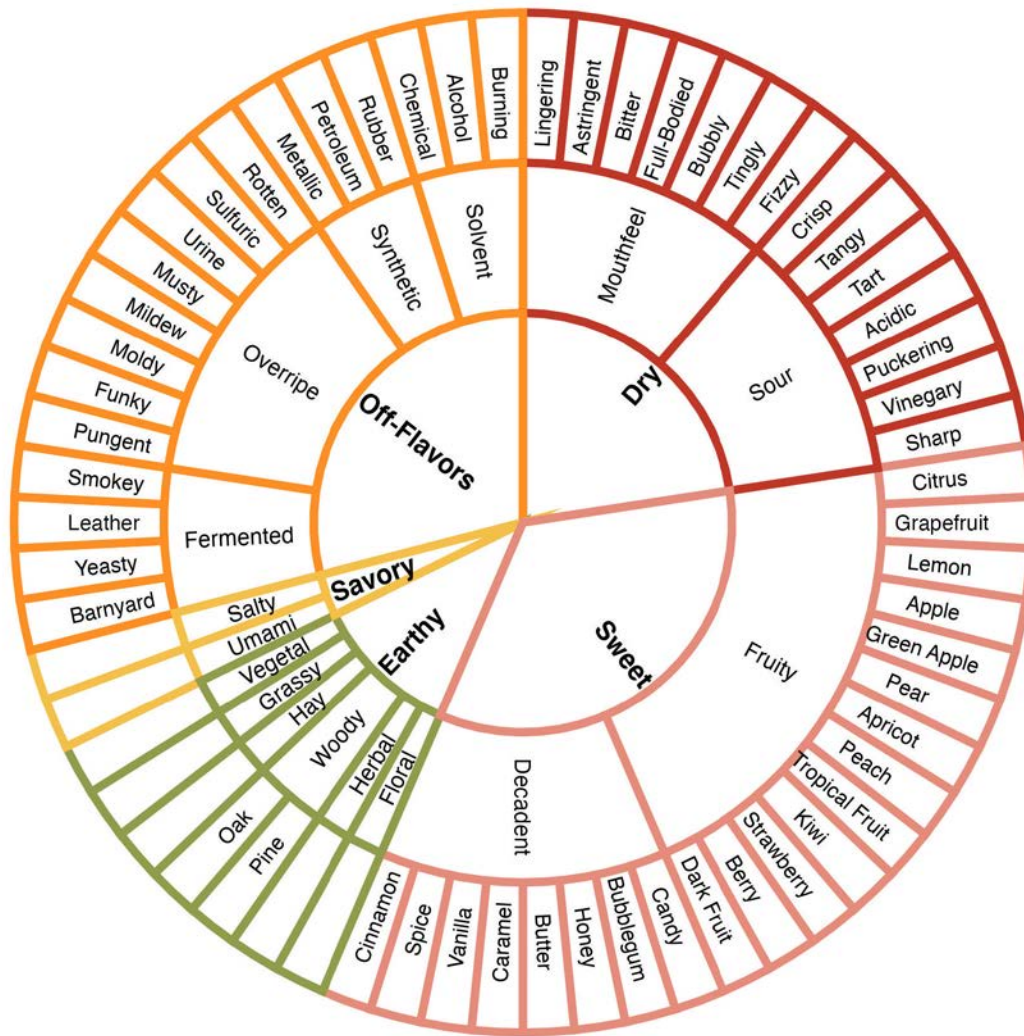


Figure 2. A proposed flavor wheel for describing hard cider made in the United States.

This flavor wheel presents the most comprehensive account of sensory descriptors that have been used to describe hard cider sensory quality to date.

7.0 Conclusions of the Hard Cider Sensory Project

This White Paper was prepared by a team of researchers and faculty at Virginia Tech who reviewed all content of the described research and synthesized the major components and findings into a more accessible report with actionable recommendations for cider industry stakeholders in the US. The work and findings of all research described herein were also presented at multiple public and professional conferences that offered opportunities for comments and/or questions by other industry stakeholders, professionals, and members of the public. The work of the *Hard Cider Sensory Project* critically expanded our understanding of consumer preferences for and sensory quality of American hard cider. This research represents the most comprehensive and grounded approach to understanding and communicating cider sensory quality to date. Some major findings of this report include the following:

- Consumers have diverse flavor preferences for hard cider that are influenced by the drinking occasion; though most consumers tend to prefer dry or subtle-y sweet cider, good aromas, tartness or acidity that is refreshing but not overpowering, and subtle funkiness and complexity.
- Most consumers enjoy cider that is made with non-apple adjuncts, including seasonal ingredients, fruits, ginger, herbs, and regional or native plants.
- Information about the cider-making process can supplement the cider sensory experience by providing extrinsic markers or predictors of quality, which can guide consumers to make more reliable and satisfying purchase decisions.
- The Merlyn Dryness Scale procedures are not a reliable predictor of sensory dryness and sweetness ratings for all hard cider products.
- Sensory descriptors and residual sugar content may be useful indicators of sensory dryness-sweetness when used together.
- Detailed and diverse sensory terms can be used to meaningfully distinguish and categorize cider products. Generally, cider products made in the US tend to be either sweet and fruity, or funky, sour, and dry. These sensory differences correlate with the “modern” and “traditional” style classifications, as well as with packaging and geography.
- Cider consumers and industry professionals do not have meaningfully different word association patterns, suggesting that one flavor wheel can be used as both a marketing and quality tool.
- A flavor wheel for hard cider can serve as a valuable guide-post for describing the sensory qualities of hard cider made in the US.

8.0 Recommendations

Based on the research findings presented above, the team of researchers involved have proposed the following recommendations for communicating cider quality, specifically but not limited to sensory quality, more effectively:

8.1 Recommendation 1

Use clear, descriptive sensory terms that (1) can be easily understood by consumers, (2) have been previously confirmed to distinguish between cider products, and (3) are honest and transparent.

Flavor is a key factor influencing consumer liking of products, but before consumers may taste or even purchase a product, they need clear and honest guidance as to what a product can be expected to taste like. The focus group research conducted in Task 1 highlighted how consumers value language that is not pretentious or intimidating when it comes to describing cider flavor; therefore, it is important to consider describing cider sensory quality using terms that most consumers are assumably likely to understand. Consumers also heavily prefer brands and self-report to repeat purchase cider products that have accurate product sensory descriptions – how the product is described is a true representation of how the product actually tastes.

The results of Task 2 suggest that specific sensory terms can be used to describe sensory “dryness” and “sweetness” with some consistency. For example, terms like “bitter” and “spice” are more indicative of dryness while terms like “fruity” and “candy” are more indicative of sweetness. The sensory DA study conducted in Task 3 and the flavor wheel validation work conducted in Task 4 provide a host of sensory terms that have been confirmed to describe and distinguish cider products. These terms are not exhaustive, but they are a basic framework for talking about hard cider. It is recommended that the hard cider flavor wheel developed in Task 4 be disseminated throughout the cider industry to help give producers a word bank of terms for describing their products. This visual may also be used to provide consumers with inspiration for describing the products that they taste. For example, the flavor wheel graphic could be mounted as a print in a taproom where consumers can easily see and use it when savoring their beverage.

In expanding off of the terms generated in Tasks 3 and 4, it is important that cider sensory descriptive language should also be accurate and honest in addition to being broadly understandable. The sensory experience and flavor perception is subjective in nature – everyone tastes things differently. In order to most accurately describe a cider’s sensory quality, cider producers should ask as many people as possible what flavors they perceive in a given sample. These people can be taproom staff, family and friends, or even customers. If customers in your local area are likely to understand sensory descriptors or “tasting notes” that relate to other regional agricultural products, such as “gooseberries” or “quince”, then these are reasonable sensory descriptors to use for describing cider sensory quality. It is recommended that wine-related or beer-related sensory descriptors be avoided in order to accurately represent the true identity of a cider. For example, instead of “wine-like” or “white wine” as tasting notes, consider more detailed descriptions such as “a bright and refreshing acidity” or “notes of grapefruit, lemon, or green apple” and “a subtle alcohol aroma.” More detailed and thoughtful sensory descriptions for cider products can enable customers to get a better sense of how a cider will taste before they make a purchase or consumption decision.

8.2 Recommendation 2

Exercise “new,” non-research supported sensory terms that have easily understood definitions and do so with as many consumers and other stakeholders as possible who are external to your business.

In elaborating upon the previously posed recommendation, the sensory descriptive terms that have been confirmed to describe hard cider in research are not exhaustive of all sensory terms that can be used to describe hard cider made in the US. Sensory terms that do not appear in research (specifically Tasks 3 and 4), such as “pineapple” or “popcorn”, might still be experienced in different cider products made in the United States. It is recommended that when using new or undocumented sensory descriptive terms, that terms should have obvious or easily assumed definitions; for example, the terms “light” or “complex” can have multiple meanings but not one obvious definition. For these example terms, it is critical to name more specific or actionable features of a product that contribute to these broader, less detailed descriptions.

Tasting cider products and developing “tasting notes” with internal employees and business stakeholders is an important first step in understanding the descriptive sensory differences between cider products. However, before internally-generated, non-research supported tasting notes are used publicly, it is recommended that these new sensory terms be “tested” with as many people as possible that are external to the business. For example, physical tasting note cards could be given to consumers in a cidery taproom and returned in a “suggestion box” at the taproom register. Alternatively, a cider-maker could share a new cider product at a monthly meet-up and ask other stakeholders for terms to describe the new product. In both situations and settings, cidery owners or staff should urge others to provide honest feedback in order to develop the most reliable sensory descriptors. Probing consumer opinions in the cidery in regard to tasting notes can also be an effective way to engage consumers in reflecting on their cider tasting experiences, which supports a more cognitive and meaningful product experience that is fully voluntary (see Task 1).

8.3 Recommendation 3

Employ descriptive sensory terms that build off of sweetness and dryness, emphasize acidity and mouthfeel, and communicate basic information about cider chemistry.

Talking about the sensory quality of hard cider is a fine balance between being clear and concise while also being descriptive and detailed. As emphasized above, it is important for sensory terms to be broadly understandable and easily relatable – particularly when describing the dryness and sweetness of cider products and when moving beyond the terms “dry” and “sweet” to talk about cider quality. The results of Task 2, the Merlyn Dryness Scale validation project, offered preliminary evidence to indicate that specific terms are more closely associated with “dry” while other terms are more closely associated with “sweet.” This research also showed evidence that residual sugar content (grams/Liter) can be a quantitative indicator of basic sweetness perception. However, it is recommended that residual sugar content be communicated in a way that is more likely to be understood by consumers, for example in terms of grams per serving (12 ounce or 16 ounce), considering that the sugar content of most FDA-regulated beverages is often communicated in terms of grams per serving on nutrition facts labels. In Task 1, consumers also verbally indicated their liking of sugar content information.

The results of Task 4, the flavor wheel research, found reliable evidence of sensory descriptors which are closely associated with the term “dry” including sour-related terms, “bitter”, “astringent”, and “crisp.” Other sensory descriptors that are consistently associated with the term “sweet” include “fruity”, “decadent”, “candy”, “vanilla”, “butter”, and more. When communicating the sensory quality of cider, it is recommended that cider producers be descriptive and use these such sensory terms associated with dryness and sweetness. For example, saying a cider is “sweet and fruity” is much less descriptive and meaningful than saying a cider is “sweet with notes of apple, lime, and sour candy.”

Sweetness and dryness perception are influenced by many different forces including but not limited to acidity, polyphenol content, and alcohol content. Acidity is well-known to off-set the sensation of sweetness, and tannins (a type of polyphenol) are well-known to create a mouth-drying or “waxy”

sensation or mouthfeel in both wine and cider. Alcohol (i.e. ethanol) itself has a sweet sensation at low concentrations (i.e. ~4% v/v), and then is perceived as increasingly bitter (and eventually pungent) as concentrations rise (Waterhouse, Sacks, and Jeffery 2016). Because all of these elements can contribute to the cider sensory experience, it is recommended that producers and industry stakeholders focus on descriptive terms related to acidity, alcohol content, and mouthfeel in order to best communicate cider quality. The mention of residual sugar content and alcohol content can also be made clear, and taproom staff should work to educate consumers on how both acidity and alcohol can contribute to dryness and sweetness perception of a cider product.

8.4 Recommendation 4

Consider incorporating information, content, or marketing that clearly emphasizes what type of drinking occasion a cider product should be consumed at

Observed in Task 1 and documented in other cider sensory research, the drinking occasion is heavily influential on consumer preference for specific cider products and on their acceptance of specific types of cider products. Casual consumption occasions, such as a hot summer day, a music event, or unwinding on the porch, best cater to cider products that are light, crisp, and refreshing in their acidity, not very astringent, bitter, full-bodied, or funky, and have a medium to high amount of sugar. During these occasions, savoring a cider and reflecting on a cider's sensory quality is not the focal point of the event at hand and so background or product information should be kept to a minimum. Intimate consumption occasions are best characterized by quiet environments that allow for reflection on cider sensory quality – whether this be over a meal with close friends or at a cidery taproom or orchard. Oftentimes, ciders best suited for intimate occasions are more complex in their sensory quality. These examples of consumption occasions have been described with detail by regular cider consumers as environments that characterize and distinguish their experiences.

It is recommended that producers and stakeholders consider and communicate what type of consumption occasion is most appropriate for a given cider product. For example, taproom staff can ask customers generally what type of mood they are in, if they are looking to reflect on some of the complex flavors in a cider, or if they are looking to pair their cider with food or snacks when looking for a product recommendation. Producers and marketers can use graphics or descriptions on their packaging or other materials that allude to the most sensible consumption occasion. For example, a cider might be described as “sweet with notes of apple, lime, and sour candy and fit for a relaxing summer day with friends.”

8.5 Recommendation 5

Be thoughtful, intentional, and inclusive when describing cider production and processing information

Consumers are becoming more and more interested in where their food comes from and how it is made, especially for specialty agricultural products, such as hard cider. Information about how cider is made can include fermentation methods, production or aging time, fermentation microorganisms, bottling or carbonation methods, ingredient sourcing, extent of preservation use, and geographic or climatic factors that contribute to cider's raw material – apples. Results of Task 1 and other research on consumer preferences for hard cider suggest that consumers are interested in learning more specifically about the agricultural origins and fermentation methods of cider. Apple varieties, or cultivars, are meaningful for consumers because they provide a guidepost for making reliable purchase decisions – if someone has consumed and enjoyed a cider with Kingston Black apples before, then they may likely purchase and consume a Kingston Black cider again. Fermentation methods, such as wild fermentations, are becoming increasingly popular and appealing to consumers because they create funky, unique flavors that are not common in other alcoholic beverages.

Sharing this information with customers makes products feel more hand-crafted and meaningful, and research suggests that it influences customers' willingness to spend money on a product. Information about how a cider is made and where a cider comes from also allows consumers to cognitively reflect on the sensory outcomes of specific production practices. This in turn allows consumers to become more educated about what they like and do not like. When different cider producers use the same apple cultivars grown in different places, this also allows consumers to experience the taste of place, or terroir, which can increase their appreciation for regional agricultural products.

However, it is critical that communication about cider production be used intentionally. Cider production information should be easily understandable to the average consumer. Descriptions like “minimalist approach” or minimal interventions are unclear – but minimal use of preservatives or filtration is more definitive. Information about how a producer got into cider making or what a cider product was named after does not help consumers understand what efforts or craftsmanship went into making a cider product, nor do these elements influence cider sensory quality. It is also recommended that information about cider production be inclusive – language should be broadly understandable and should suit the drinking occasion. Too much production information when it is not desired given the consumption occasion or environment can be viewed as overwhelming and pretentious, based on the observations of consumer feedback in Task 1.

9.0 References

- Betancur, M. I., Motoki, K., Spence, C., & Velasco, C. (2020). Factors influencing the choice of beer: A review. *Food Research International*, 137, 109367. <https://doi.org/10.1016/j.foodres.2020.109367>
- Calvert, M. D., Cole, E., Stewart, A. C., Neill, C. L., & Lahne, J. (2022). Can Cider Chemistry Predict Sensory Dryness? Benchmarking the Merlyn Dryness Scale. *Journal of the American Society of Brewing Chemists*, 1–6. <https://doi.org/10.1080/03610470.2022.2121562>
- Calvert, M. D., Neill, C. L., Stewart, A. C., & Lahne, J. (2022). Sensory descriptive analysis of hard ciders from the Northeast and Mid-Atlantic United States. *Journal of Food Science*. <https://doi.org/10.1111/1750-3841.16507>
- Kim, S.-E., Lee, S. M., & Kim, K.-O. (2016). Consumer acceptability of coffee as affected by situational conditions and involvement. *Food Quality and Preference*, 52, 124–132. <https://doi.org/10.1016/j.foodqual.2016.04.008>
- Lahne, J., & Trubek, A. B. (2014). “A little information excites us.” Consumer sensory experience of Vermont artisan cheese as active practice. *Appetite*, 78, 129–138. <https://doi.org/10.1016/j.appet.2014.03.022>
- Lawless, H. T., & Heymann, H. (2010a). Context Effects and Biases in Sensory Judgment. In H. T. Lawless & H. Heymann (Eds.), *Sensory Evaluation of Food: Principles and Practices* (pp. 203–225). Springer. https://doi.org/10.1007/978-1-4419-6488-5_9
- Lawless, H. T., & Heymann, H. (2010b). Introduction. In H. T. Lawless & H. Heymann (Eds.), *Sensory Evaluation of Food: Principles and Practices* (pp. 1–18). Springer. https://doi.org/10.1007/978-1-4419-6488-5_1
- Lea, A. G. H., & Arnold, G. M. (1978). The phenolics of ciders: Bitterness and astringency. *Journal of the Science of Food and Agriculture*, 29(5), 478–483. <https://doi.org/10.1002/jsfa.2740290512>
- Meiselman, H. L. (2019). *Context: The Effects of Environment on Product Design and Evaluation*. Woodhead Publishing.
- Nijman, M., James, S., Dehrmann, F., Smart, K., Ford, R., & Hort, J. (2019). The effect of consumption context on consumer hedonics, emotional response and beer choice. *Food Quality and Preference*, 74, 59–71. <https://doi.org/10.1016/j.foodqual.2019.01.011>
- Phetxumphou, K., Cox, A. N., & Lahne, J. (2020). Development and Characterization of a Check-All-That-Apply (CATA) Lexicon for Virginia Hard (Alcoholic) Ciders. *Journal of the American Society of Brewing Chemists*, 78(4), 299–307. <https://doi.org/10.1080/03610470.2020.1768784>
- Symoneaux, R., Baron, A., Marnet, N., Bauduin, R., & Chollet, S. (2014). Impact of apple procyanidins on sensory perception in model cider (part 1): Polymerisation degree and concentration. *LWT - Food Science and Technology*, 57(1), 22–27. <https://doi.org/10.1016/j.lwt.2013.11.016>
- Symoneaux, R., Guichard, H., Le Quéré, J.-M., Baron, A., & Chollet, S. (2015). Could cider aroma modify cider mouthfeel properties? *Food Quality and Preference*, 45, 11–17. <https://doi.org/10.1016/j.foodqual.2015.04.004>
- Waterhouse, A. L., Sacks, G. L., & Jeffery, D. W. (2016). *Understanding Wine Chemistry*. John Wiley & Sons, Ltd.