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A REVIEW OF SENSORY QUALITY CONTROL AND QUALITY ASSURANCE FOR ALCOHOLIC BEVERAGES

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Abstract

Tools are available, through various reference books, to develop a purposeful sensory quality program. Some companies already have a strong sensory program in place; others may require a cultural change to facilitate the implementation. This paper indicates some of the challenges to be overcome, covers some current quality control (QC) sensory practices and addresses advantages and disadvantages of expert tasters Some specific issues regarding sensory evaluations of alcohol beverages are discussed and critical factors in production are reviewed with discussion on the potential for off taint development.

Key words: alcohol beverages, sensory quality, expert tasters, off odors, quality control

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Acknowledgements

"The final version of this report, with additional sections, is included as a book chapter titled "Quality Control and Assurance through Sensory Evaluation" in the book, "Alcoholic Beverages: Sensory Evaluation and Consumer Research (Editor, J. Piggott, Woodhead Publishing)".

Chapter 1 - Introduction

There are numerous reference materials on sensory quality and its place within the Quality Control (QC) / Quality Assurance (QA) function. These reference materials give explicit detail on how to plan, set up, and implement a sensory program for QC. Most current sensory analysis books devote at least a chapter on the subject. The American Society for Testing and Materials (ASTM), for example, published a 52 page manual detailing the intricacies of implementing a sensory program in a manufacturing plant's QC environment. "…[T]o bring sensory testing for quality control … out of the 'touchy/feely' and value judgment realm into the world of quality control data reporting" (Yantis, 1992, p 49).

Despite availability of such reference materials, the integration of sensory evaluation into the areas of QC/QA has achieved only moderate success throughout the food and beverage industries. As Stone and Sidel (1993, p 295) mention, "…most QC sensory programs have not been as successful as anticipated." Even after nearly two decades that statement holds true; and the success of these programs in the alcohol beverage industry is no exception.

Stone and Sidel (1993) speculate that the lack of success in the implementation of sensory programs is likely a result of the organizational environment. This is reasonable because many manufacturing plants operate under the old axiom, "if it's not broke, don't fix it". The challenge is for QC sensory professionals that understand the benefits of a well run sensory program to continue to enlighten industry management by demonstrating the efficiency and practicality of a sensory quality model. The difficulty of this challenge is in describing the benefits of a sensory program and how it can save time and money, while concurrently increasing value for consumers. Phrased in this manner the business case in support of a QC sensory program is more meaningful to management than scientific jargon about statistical power, repeatability or reproducibility.

Chapter 2 - Sensory quality concerns and issues in the alcohol beverage industry

Most alcohol beverage manufacturers perform some form of flavor evaluation on their products. Some companies, typically the larger ones, have an established sensory group/department responsible for the overall sensory programs used in the production facilities' QC departments. In these instances, the sensory group will communicate, as needed, standard operating procedures, conduct and monitor panel training and interpret results for corrective actions. Other companies perform sensory testing on an ad hoc basis where the evaluations are conducted to meet the needs of a specific situation. On this point, it should be understood that many recognizable brands in the alcohol beverage industry have been producing products much longer than current organized sensory practices have been in use. The implication is not that sensory quality is an unimportant aspect in these products' production. In fact; the United States Bottled-in-Bond Act of 1897 was enacted to protect whiskey consumers from illicit and often lethal productions of blended whiskey. The Bottled-in-Bond Act is considered a precursor for the U.S. Pure Food and Drug Act of 1906. Despite providing no direct guidance for sensory quality, whiskey labeled as Bottled-in-Bond came to known as "the good stuff" because the Act did provide assurance to the consumer (Veach, nd).

Meiselman and Schutz (2003) note that the old Seagram's™ company was one the first companies, in any industry, to embrace sensory techniques established in the 1940's by the U.S. Army's Quartermaster Corps. Throughout the 1900's, Seagram's™ was one of, if not, the largest distilled spirits companies in the world. The Seagram's™ brand still exists, but is currently owned by Diageo™. Meiselman and Schutz (2003, p200) describe the hiring of David Peryam and Norman Giradot; two of Seagram's™ quality control scientists, by the US Army's laboratory in 1949 as a critical step that led to the development of many sensory analysis techniques still in use today. It is apparent that the alcohol beverage industry has made an important impact in the development of sensory evaluation methods and in general the field of sensory analysis as a whole. Despite this link in the development of sensory evaluation methods to the alcohol beverage industry, many companies still lack proper support for and use of sensory quality practices. Munoz (2002, p327) stated, "Current QC/sensory programs in industry cover the whole gamut of "quality", from "expert" measures similar to those used a century ago to state-of-the-art programs."

At some point in the history of QC evaluations of alcohol beverages the phrase organoleptic testing crept into industry's vocabulary. Though organoleptic testing does refer to the use of the senses for product evaluations that is where the comparison to sensory evaluations stops. Sensory evaluation involves greater attention to details such as methodological assessor training, sample preparation, and recording and reporting steps, that are useful to the scientific evaluation of products. Therefore, organoleptic tests are a more qualitative, subjective method, whereas sensory evaluations typically have a more scientific basis. In this context it is not surprising that most sensory texts avoid discussing the use of organoleptic testing. Since at least the early 1980's, sensory professionals have been trying to eliminate the use of the word organoleptic from the practice of product evaluations (Jellinek, 1985; McDaniel, 1985). The problem is that many people continue to use the words, organoleptic and sensory, in the same context. The misuse of these words is especially prevalent in the alcohol beverage industry. It is important for the laboratory analyst, sensory scientist, or whoever is charged with the function of product quality assessment, to fully understand these differences, and the deficiencies related to organoleptic testing. It is also important to understand that the terms; organoleptic testing and sensory evaluation, are not synonymous and should never be used interchangeably.

A similar but perhaps more damaging effect to the integrity of sensory practices, has been its misuse. It is not at all uncommon to find QC staffs combining difference tests, e.g., triangle tests or paired comparisons with a preference test. Many researchers have commented on the misapplication or combining of test methods and the resulting problems from this practice (Stone and Sidel, 1993; O'Mahony, 1986). Stone and Sidel explained the inherent problems (1993, pp 196) as follows:

- Odd sample bias – Panelists tend to prefer samples that are not perceived as different (or odd in the case of a triangle test) from a reference. Since the initial test is to determine sample difference, panelists are now predisposed to a preference bias.
- Skewed results – Panelists for a discrimination test are recruited based on their acuity and usually specific experience looking for differences in a product

- Small sample sizes – Discrimination tests typically use 20 – 30 panelists while preference/acceptance tests require much larger panel sizes.
- Transition of tasks – It is more difficult than it might appear to mentally “flip the switch” from trained discriminator to consumer, which potentially leads to odd sample bias.
- Making sense of the results – Do you only include those preferences from subjects that were correct on the difference test? Do you include the preference from all subjects?

Additionally, the use of preference tests as part of plant sensory quality does not make practical sense, because a primary role of QC is to make a product consistently, irrespective of personal likes or dislikes. Other common misuses of sensory practices include the use of discrimination test methods (i.e. triangle or duo-trio tests) with too few respondents for statistical relevance, repeated test panels to achieve a desired result and having panelists evaluate more than one set of samples on the same test to increase the number of responses.

Review of current sensory practices in the alcohol beverage industry

Because the goal of QC is to maintain a consistent and standard quality product from one production to another, the use of difference tests (triangle, duo-trio, paired comparisons and the like) often are used. These types of tests are more likely to be conducted by a QA or corporate sensory group using their own set of trained panelists than by a plant’s QC group. These tests typically require a larger number of panelists and more time than a QC lab has available. Difference tests are useful to evaluate the acuity (the ability to discriminate) of panelists on a particular product or attribute (or sometimes a defect) of a product.

It is more common to find simple “go/no go” comparison tests, using smaller panel sizes; 3 – 6 panelists, for quality control evaluations. In these tests a sample is compared to a reference standard of the same product, the panel will then determine whether or not the sample is comparable to the reference sample. If it is determined to be comparable by the panel, the product is released for use. If it is not approved, then the decision as to what corrective action is required must be made. A key aspect of this type of determination is what is comparable. Usually, “comparable” means that there is an expectation that consumers would identify or accept the product in the package as typical or representative of the expected product. This type of testing requires that the panelists have some training and background in typical or representative product and then use good judgment in determining whether finding small, sometimes inherent, differences result in the product being comparable.

When product is not found to be in compliance with standards, the corrective action may involve blending off the unapproved product in small amounts with approved batches and retesting to ensure that the new blend is not compromised in quality. Other times the decision is to re-work the product by going through additional processing, i.e., additional filtration.

Occasionally, when a panel cannot reach a consensus to accept or reject, the questionable product will go to a larger difference panel, i.e., triangle, duo-trio or paired comparison. This panel will determine whether there is a significant difference between two samples – the test sample and a control batch selected as typical or representative. It is critical in these cases to have large enough panels that decisions of no-difference can correctly be interpreted.

Also it is common to find multiple sample comparison tests in use by QC areas. These types of tests are useful when multiple production samples of the same product are available; usually 3 to 5 products compared to a reference. This test type can be conducted as either a scaled test whose results are analyzed using ANOVA, or a ranking of samples for difference by Friedman analysis (Meilgaard et al., 2007). These types of tests often require 8 – 12 panelists, so their use may be restricted based on the number of panelist available.

Descriptive analysis methods are less common throughout the alcohol beverage industry. Some producers, most notably the larger beer and wine companies, use descriptive analysis methods to define product flavor profiles. The information gathered from descriptive testing on a product's flavor profile can be used to train panelists in the identification and intensity of critical product characteristics. Such information also may help the sensory staff understand sensitivities that particular individuals on QA/QC panels have to specific flavor compounds that may influence his/her decisions. Research also suggests that trained sensory panel results may be useful as predictive indicators of consumer acceptance (Rousseau, 2010; Lattey et al, 2010; Drake and Civille, 2002) although such predictions would need to be determined on a product by product basis. Again, it is important to emphasize that a QC/QA test rarely is designed simply to test "overall acceptability" or "liking", but rather to ensure that products meet agreed upon standards of typicality and representativeness.

Advantages and disadvantages of expert tasters

Master brewer, cellar master, enologist, winemaker, master distiller and master blender, these are some of the titles used in alcohol beverage industry that indicates “experts” in their field. The expertise of these individuals is not only about their acuity as part of a difference panel or their descriptive abilities, but also refers their knowledge of the production process and the products (Hughson and Boakes, 2002; Lawless, 1985).

Use of the term “expert” can be misleading, in regards to who is responsible for the sensory quality of a product. Is it the individual or the panel that has the responsibility for sensory quality? It is true, at least in the not too distant past, that “experts” would be the final decision makers regarding a product’s quality. This way of working has changed in recent years in many companies. Although there are individuals who have in-depth knowledge of and experience with specific products, these individuals rarely make sensory quality decisions exclusive of other’s input. In many cases where “experts” make a final decision, they also participate on panels and use the panel’s results to help form their decisions of a particular product’s quality. These panels usually evaluate products on a “go/no go” basis. Training of new panelists in this setting often takes place in what can be described as an apprenticeship with the expert and the panel. There obviously are problems with this training method i.e., lack of standardized training protocols, understanding individual’s sensitivities and anosmias, and the effect of panel influences among others.

Training and maintenance protocols for panelists are what set sophisticated sensory programs apart from other programs. All companies want to produce the most consistent quality products possible. However, companies that have sensory procedures in place without a sensory program strategy and strong management support typically have fewer resources (i.e., time, money and people), made available to them than their counterparts in other companies. Granitto et al., (2008, p590) stated, “the most difficult and time consuming stage of sensory profiling is probably the selection and training of a panel, in the attempt to reach agreement in the use of scales and in the meaning of each attribute.”

Thorough training and maintenance protocols for the development and assessment of panelists have been implemented by some companies, but there are many who still rely on “expert” tasters to evaluate their products. There have been many published reports on improved reliability of trained sensory panels over the “expert” tasters. (Guinard et a.l, 1998; Latreille et al., 2006; and Gawel and Godden, 2008). There is no argument that training of panelists improves reliability of results. The research by Guinard et al., (1998, p59), for example, suggests that “expert” tasters’ judgments differ significantly from person to person when asked to evaluate the quality of a variety of beers.

Basic issues in sensory evaluation of alcoholic beverages

All food and beverage categories have their own inherent sensory quality issues related to storage, serving, handling and evaluation. One of the key aspects of importance with alcoholic beverages generally is the alcohol content; most of the world uses the terminology percent alcohol or percent alcohol by volume (% abv) to express alcohol content. In the U.S., and with primary regard to distilled spirits, the term proof is used to express alcohol content. U.S. proof units are double the percent alcohol of a given product. For clarity and consistency in this chapter’s discussion, only the term percent alcohol will be used in reference.

Reducing alcohol content for sensory evaluations

Alcohol can desensitize the palate and nose of the assessor if evaluations are conducted on products with high percent alcohol. Even when assessors expectorate, they may still become adapted and desensitized by evaluating samples with high alcohol content. This is caused, in part, by the ease with which alcohol can be absorbed through the soft tissue of the mouth unless proper caution and common sense is employed.

Another reason for reducing alcohol content by dilution is that it can be much easier to expose off-taint characteristics that otherwise may have gone undetected. For example, geosmin, an aromatic compound caused by blue-green algae growth, exhibits an earthy, musty character. The sources of geosmin contamination typically include the production water and/or the grain, fruit, and other raw material substrates from which the alcohol is initially derived. It is much easier to detect geosmin when alcohol content is diluted.

One problem with dilution is that delicate flavor notes, particularly in some highly aged products can be diluted to the point that they are lost or overwhelmed by other characteristics. This presents a problem that must be addressed on a case-by-case basis by the company in determining whether dilution is necessary and appropriate.

Most wines and beers are of low enough alcohol content that alcohol reduction is not required before testing. However, for those distilled spirit products with greater than 35% alcohol content, it is common practice to dilute the alcohol content using de-ionized or distilled water. Depending on the producer of the product, the range for evaluation can be from 15% - 25% alcohol content. It is important that a single diluted alcohol content is adhered to for quality assessments of a product. Varying the alcohol content from one panel to the next can cause confusion and erroneous results. There is a simple formula to use when diluting alcohol content of a product;

Figure 2-1 Alcohol dilution formula

$$\frac{\text{desired product volume} \times \text{desired alcohol content}}{\text{current alcohol content}} = \text{required product volume at current alcohol content}$$

The remaining desired volume would be filled with de-ionized water to bring the product to the desired alcohol content.

Selection of serving ware as a tool for sensory evaluations

In conventional practice most QC labs use tulip-shaped glasses, often a short stemmed glass with a bulbous body (narrower at the opening than at the base), for their evaluations. However, as Piggott and Macleod (2010, p 264) note there is no scientific research to demonstrate improved flavor detection using this type of glassware. Some companies have opted to move away from glass altogether for their product evaluations, citing several factors for this change: 1) time and energy/water savings from washing: 2) avoidance of sample-to-sample contamination, because even after washing, some products leave residual flavors behind (e.g., compounded gin with very flavorful essential oils is difficult to neutralize); 3) avoidance of residuals from detergents as well as the rinse water, residual calcium from rinse water can inhibit the detection of geosmin (Schrader and Blevins, 2001); and 4) replacement, both from a cost perspective but also in sourcing glass from the same glass manufacturer and glass mold.

The requirement remains that whatever serving ware is selected it must be vetted for product compatibility, meaning that the vessel will remain inert and will not impact the product evaluation. An outline of how to screen raw materials; including transfer and containment vessels is presented in section 3.4, pertaining to processing and product transfer.

Other special concerns related to the sensory evaluations of alcoholic beverages

Along with the previously discussed issue regarding alcohol content, Piggott and Macleod (2010) also provide insight to other areas of special concern when evaluating beverage alcohol. These areas of concern include: 1) time from sample preparation to serving and evaluation; 2) sample serving temperature; and 3) the topic of nosing as compared to tasting. The first of these, time from preparation to serving, suggests serving as close to a fresh preparation as possible. Nonetheless those authors recognize that this is not always a possibility and conclude that most sample preparations (e.g., that are not temperature sensitive or time sensitive in the case of carbonated beverages) may be pre-poured and held for evaluation up to eight hours without noticeable differences in results. Next is sample serving temperature with the basic concern being that although products generally may be served at a wide range of temperatures; product comparisons of a given product should always be served at the same temperature. The last topic, nosing, is a common practice given the number of samples that a QC lab may evaluate daily. In many labs the appearance and smell of the product are determined during nosing and used to determine whether the product will pass QC sensory tests. In those cases, the product may not actually be tasted. This presents a conundrum that must be understood no matter what testing decision finally is made. It may be important to control the amount of beverage that is tasted, because the alcohol content can result both in adaptation and desensitization and can produce physiological effects if over-consumed,. Even if assessors do not swallow the samples being evaluated, the alcohol can still be absorbed through the mouth. This information suggests that nosing, without actual tasting is preferred. However, tasting the sample can release flavors or heighten certain flavors that would not be detected in the same way if the sample is only smelled. Again, companies need to make decisions based on informed discussion before deciding on a specific set of protocols. Regardless, if the samples are being tasted, expectorating almost always is encouraged when numerous samples (more than three or four depending on alcohol content) are to be evaluated in a single session.

Two other areas of concern for quality evaluations to be considered include sample order and the sample number and serving size. It is not uncommon for the quality assessor to be involved in multiple evaluations of a variety of products. If this is the case, samples should be organized in an order of least flavorful, i.e., most neutral, such as vodka, to more heavily flavored products such as gin or a full bodied red wine. Flavor impact is not the only concern because mouth-feel and texture also come into play when considering sample order. More viscous types of products may leave a mouth coating that can influence subsequent evaluations.

The number of samples and serving size is critical to sensory quality assessment and even more so if consumers are involved in the QA process as they might be when standards are first established or are checked to determine if modifications are necessary. The Distilled Spirits Council (DISCUS) of the U.S. lists one of its main goals as the promotion of responsible drinking. They have published guidelines comparing serving sizes of distilled spirits, wine and beer. In a press release on 22 April, 2010 DISCUS proposed, "[s]erving sizes are 1.5 fluid ounces for 80-proof distilled spirits, 12 fluid ounces for regular beer, 5 fluid ounces of wine." These guidelines are important for all researchers and participants involved with alcohol beverage evaluations to understand. Likewise, when conducting consumer research it is the responsibility of the manufacturer to understand the laws regarding total allowable serving volume, which affects the number of samples that may be presented as well as the serving size that each respondent can receive. Tables 1 and 2, below, show equivalent number of servings based on serving size and alcohol content. It should be noted these are not recommended serving sizes for individual samples for testing purposes, but rather are included only to help make comparisons for total alcohol consumption during testing based on total amount consumed during a test.

Table 2-1 Equivalent serving volumes (fluid ounces)

Serving Size Equivalents (in ozs)
Based on alcohol content and number of samples
1 fluid ounce = 29.57 milliliters

	Number of Samples Presented					
proof	**1**	**2**	**3**	**4**	**5**	**6**
5	24.00	12.00	8.00	6.00	4.80	4.00
10	12.00	6.00	4.00	3.00	2.40	2.00
15	8.00	4.00	2.67	2.00	1.60	1.33
20	6.00	3.00	2.00	1.50	1.20	1.00
25	4.80	2.40	1.60	1.20	0.96	0.80
30	4.00	2.00	1.33	1.00	0.80	0.67
35	3.43	1.71	1.14	0.86	0.69	0.57
40	3.00	1.50	1.00	0.75	0.60	0.50
45	2.67	1.33	0.89	0.67	0.53	0.44
50	2.40	1.20	0.80	0.60	0.48	0.40
55	2.18	1.09	0.73	0.55	0.44	0.36
60	2.00	1.00	0.67	0.50	0.40	0.33
65	1.85	0.92	0.62	0.46	0.37	0.31
70	1.71	0.86	0.57	0.43	0.34	0.29
75	1.60	0.80	0.53	0.40	0.32	0.27
80	1.50	0.75	0.50	0.38	0.30	0.25
85	1.41	0.71	0.47	0.35	0.28	0.24
90	1.33	0.67	0.44	0.33	0.27	0.22
95	1.26	0.63	0.42	0.32	0.25	0.21
100	1.20	0.60	0.40	0.30	0.24	0.20

Table 2-2 Equivalent serving volumes (milliliters)

Serving Size Equivalents (in mls)
Based on alcohol content and number of samples
30 milliliters = 1.014 fluid ounces

	Number of Samples Presented					
% ABV	1	2	3	4	5	6
2.5	709.68	354.84	236.56	177.42	141.94	118.28
5.0	354.84	177.42	118.28	88.71	70.97	59.14
7.5	236.56	118.28	78.85	59.14	47.31	39.43
10.0	177.42	88.71	59.14	44.36	35.48	29.57
12.5	141.94	70.97	47.31	35.48	28.39	23.66
15.0	118.28	59.14	39.43	29.57	23.66	19.71
17.5	101.38	50.69	33.79	25.35	20.28	16.90
20.0	88.71	44.36	29.57	22.18	17.74	14.79
22.5	78.85	39.43	26.28	19.71	15.77	13.14
25.0	70.97	35.48	23.66	17.74	14.19	11.83
27.5	64.52	32.26	21.51	16.13	12.90	10.75
30.0	59.14	29.57	19.71	14.79	11.83	9.86
32.5	54.59	27.30	18.20	13.65	10.92	9.10
35.0	50.69	25.35	16.90	12.67	10.14	8.45
37.5	47.31	23.66	15.77	11.83	9.46	7.89
40.0	44.36	22.18	14.79	11.09	8.87	7.39
42.5	41.75	20.87	13.92	10.44	8.35	6.96
45.0	39.43	19.71	13.14	9.86	7.89	6.57
47.5	37.35	18.68	12.45	9.34	7.47	6.23
50.0	35.48	17.74	11.83	8.87	7.10	5.91

Chapter 3 - Similarities and differences of alcoholic beverages

The most basic similarity of beer, wine and distilled spirit products is quite obvious, they all contain alcohol in the form of ethanol. The alcohol content of these products arguably affects their sensory quality more than any other single factor. For example, the fermentation process that produces ethanol also contributes to the formation of several volatile aromatic compounds including acetaldehyde, diacetyl, acetic acid and numerous other compounds. The equilibrium of ethanol and other compounds produce further aromatic compounds; an example would be the formation of ethyl acetate through the esterification of acetic acid in the presence of ethanol. Additionally, alcohol influences the sensory quality of these products by the fact that it is an active solvent. This ability to serve as a solvent for other flavor fractions has an impact on the sensory testing of the products. As products become more complex and more flavorful, QC testing become more difficult both from the standpoint of the typicality of the product and the timing and serving protocols that must be considered.

The alcohol content of a product also impacts the maturation process of products that are aged in wood, the order of addition and solubility of ingredients in compounded products (e.g. cordials, gins, blended whiskies to name a few) and the shelf stability of products as well.

The differences that affect the sensory quality for beer, wine and distilled spirits are numerous. The first difference is the fermentable substrates used in the production of each type of product. Next, the production processes for wine, beer and distilled spirits are quite different. Some products are carbonated, some are aged in wood and others require filtration. The operational controls that must be included for sensory testing of the various products are product specific and must be considered based on the total product and its intended use.

Chapter 4 - Factors influencing the development of off-flavors and taints

Raw materials

Water is a critical component in the production of all alcohol beverages. The quality of water used in production often goes unnoticed when there are no problems, but when quality issues arise in production, water is one of the primary suspects. The use of water is ubiquitous throughout production. Whether water is limited in use to rinsing and cleaning production vessels or it is added as an ingredient in the production process (e.g., beer and distilled spirit productions), the quality of water is essential to the quality of the finished product. Routine evaluations to monitor water quality should be included as part of a sensory quality program, because conventional water treatment procedures are not always adequate to remove off-odors (Srinivasan R and Sorial G, 2011). Geosmin and 2-methyl isoborneol (2-MIB), which have been described as having earthy and musty notes respectively, are two of the most problematic taints found in water.

All alcohol starts from some sort of fermentable substrate (e.g., grains, fruits or tubers to name a few). Any material that contains simple sugars, or complex carbohydrates that can be converted into simple sugars, has the potential to produce alcohol through fermentation. Establishing sensory procedures to evaluate these materials as they come into the production facility adds assurance that new shipments meet predetermined quality criteria for flavor and consistency. A common method used for grain evaluations involves making a "tea" where hot water is poured into a glass containing the grain. This sample is compared side-by-side with a reference sample of the specific grain, prepared in the same way. Often it is the grain operators/receivers who are charged with this responsibility, which works only if they are given procedural support and training to conduct these evaluations. Common off-notes that can be detected by this method include geosmin, 2-MIB, and diesel fuel (used commonly in machinery to dry grains).

The yeast variety used in fermentation also impacts the flavor of the finished product (Lilly et al, 2000; Lee et al, 1995). Many companies choose to use dry yeast, because it allows for more consistent yeast application and is less costly to maintain. Though use of dry yeast does not prevent cross-contamination from wild strains, there is less opportunity for this interaction. Companies that choose to propagate their own proprietary strain of yeast must do so with care. Wild yeasts are everywhere and can mutate a particular strain of yeast if proper control conditions are not in place. Proper sensory testing to ensure that no extraneous flavors are formed by unexpected yeast contamination is essential.

Operational controls

Time, temperature and pH are critical operational control points in the production of alcohol beverage. Beer and many spirits products begin with a mashing process, where grains are cooked with water (i.e., the mash) to gelatinize the starch content of the grains. Obviously to cook the mash, the temperature is elevated. However, prior to the addition of enzymes, or malt in the case of straight whiskies, that is used to convert the starches to fermentable sugar, the temperature must be reduced so as not to inhibit this enzymatic action. As the mixture is transferred into a fermenter it must continue to cool before the yeast is added. In some products an additional cooling step takes place prior to the enzyme addition. For bourbon production, for example, milled rye is added to mash. If the rye is added at too high a temperature it will form "rye balls" (i.e., the rye meal will clump together). The interior portion of the "rye ball" does not get cooked. This uncooked rye meal can act as a medium for bacteria growth, which can contaminate the fermenter. Increased levels of phenolic compounds (e.g., ethyl phenol and ethyl guaiacol) are associated with contaminated fermentations due to the presence of "rye balls". In addition to proper temperature control, the yeast activity in the fermenter is influenced by the pH of the mash. Each yeast strain operates at its own optimal pH range. Control of pH in the fermenter will impact the yield and quality of the alcohol produced (Bra'nyik et al, 2004; Davis et al, 1985). Sensory testing during the production process, often by nosing intermediate products of the production, can help to determine if problems are occurring before additional processing steps compound the problems.

There are other operational controls to minimize the risk of product contamination. Proper sanitation and cleaning of all equipment is critical. Cleaning minimizes bacteria and mold growth potential as well as reducing the chance of cross-contamination from shared equipment. In plants with stills, keeping copper portions of the still clean reduces the occurrence of sulfur compounds. Clean, active copper sites will bind sulfurous compounds to minimize their migration through the still. Many companies have adopted closed-topped stainless steel fermenting tanks. In the past, fermenters often were open-topped wooden containers. Stainless steel is easier to clean and sanitize than wood. The closed system also reduces contamination from air-born wild yeast and bacteria (Bra'nyik et al, 2005).

Maturation/Storage

Some wines and spirits are aged, often in oak barrels. This process is known as maturation. The sensory impact from maturation can be huge depending on the length of time the product ages, the type and size of the barrels, alcohol content in the barrel, and whether the barrel is a new charred or reused barrel. It is possible to underage and overage products. Not enough time and the product may appear immature. Too much time the product may be considered over-aged. Product in smaller barrels will mature (i.e., gain more wood character) more quickly than product aged in larger barrels, because the ratio of surface area to volume is greater in the small barrels. French oak provides a different flavor (drier more tannic flavor) profile than American white oak (more vanilla notes). Product with higher alcohol content will extract more tannins than a lower alcohol content product. More delicate distilled spirits (e.g., rum, Canadian whisky and malted whiskies) are aged in reused barrels. Straight whiskies (e.g., bourbon and rye whiskies) are aged in new charred oak barrels, as prescribed by U.S. law. Research also suggests that barrel aging can contribute increased levels of phenolic compounds in wine (Rayne, 2007). The difficulty in sensory testing of these products is that the product changes considerably during the aging process and the initial product going into the barrel is quite different from the ending product. However, it is clear that poor quality, tainted, product entering the aging process will not improve with age.

Processing and product transfer

All materials that come into contact with product must be tested to ensure that the material will not alter the flavor of the product. These materials include, but are not limited to, filter pads, filter media, hoses, and gaskets. A 72 hour test should be sufficient to evaluate the integrity of these materials, since they are not intended to be in constant with product for an extended period of time. A common method for doing this is to use grain neutral spirits, at 95% abv, and place a sample, at least 2.5cm2 in size, of the material into a beaker. Add 150ml of the grain spirits and cover the beaker. When evaluating hose materials it important to receive a long enough length that it can be bent into a u-shape. The grain spirits is then placed inside the hose. Be sure to note the start time of the test and retain enough of the original spirits to use as a reference for evaluation at 2, 6, 24 and 72 hour increments. At each increment dilute samples of the reference and the test material to 20% abv for evaluation.

Packaging materials

Finished product containers (e.g., cans, glass and PET) and closures also need to be evaluated for product compatibility. The difference here is that these materials will be in contact for a much long time period. Packaging materials can initially be reviewed using the 72 test as described above, but for approval these materials must be placed into long-term storage testing containing product similar to what it is intended to hold. Test increments for can vary; but increments of 1, 3, 6, 9 … 24 months often are recommended.

If closures are being tested it is suggested that the container be laid on its side to maximize product contact. Historically, natural cork has been used as a closure with many alcohol beverage products. Over the past 20 years, many companies have replaced natural corks with synthetic cork. Natural corks have the disadvantage of occasionally imparting an off odor, 2,4,6-trichloroanisole (TCA), with odor characteristics similar to geosmin or 2-MIB.

Chapter 5 - The use of instrumental methods to aide sensory quality evaluations

Analytical instrumentation, namely Gas Chromatography – Flame Ionization Detector (commonly called GC-FID) and High Performance Liquid Chromatography (often called HPLC) has been useful in the quantification of volatile compounds and barrel extractives, respectively. Until recently, analytical equipment has been limited by its detection capabilities. Many taint compounds, such as geosmin, 2-MIB, TCA and sulfurous compounds, have best been detected by the human nose, but have low detection limits, in the ppb and ppt range. Advancements in analytical detection due to advancements such as stir bar sorptive extraction (SBSE) have made it possible to quantify compounds at these very low levels (Nakamura et al, 2001). SBSE technology requires the use of GC-Mass Spectroscopy. Most QC labs do not contain these instruments because the cost of the equipment and the associated maintenance and staff to run the equipment is high. However, if such equipment is available in a research and development laboratory it can be used to identify and quantify potential training standards for a sensory quality panel, in addition to the other advantages these equipment have as research tools.

Chapter 6 - Conclusions

Great strides have been made in the alcohol beverage industry to improve sensory quality programs, but room for further improvement exists. Continued training is the key to the successful implementation of sensory programs as well as a means of retraining employees to an enhanced understanding of quality. Training should include discussions with management to establish quality goals, but should integrate other functional groups within the company, especially those groups involved in activities that can influence the development of off-odors and taints.

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