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Sensory Comparison of Beer Carbonated Using Forced Carbonation and the Carbo Rock-It

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Abbreviations and Acronyms

CO_2 – carbon dioxide
IPA – India Pale Ale
Carb – carbonation

Abstract

Craft brewing is a growing market which represents over 12% of beer produced in the United States. Dr. G Scott Osborn, PE invented the Carbo Rock-It™ to improve the carbonation process for craft breweries. The invention allows for shorter carbonation time and uses less CO_2, saving companies money and time. Because of the lack of gas losses through bubbling, Osborn theorized that the Carbo Rock-It could also prevent the "stripping of the nose" that can occur in traditional forced carbonation. Existing research supports the mechanism, as beer flavor and aroma volatiles have been detected during the release of CO_2 when a beer is served. Additionally, supporting anecdotal evidence from brewers indicates that strong beer aromas fill the room during carbonation. If it can be proven that Carbo Rock-It beer retains more flavors, and it is preferred by consumers, the Carbo Rock-It can be better marketed to craft brewing companies. This study used the triangle test discrimination method to determine if beer-drinkers can perceive a difference between force-carbonated beer and Carbo Rock-It beer. An IPA-type and a lager-type beer were tested on 86 panelists in coordination with the Sensory Science Center at the University of Arkansas. It was found that there was a perceivable difference in the IPA but not in the lager. This result suggests that the Carbo Rock-It does influence the flavor of beer, but the ability for that impact to be perceived depends on the composition of the beer. The IPA has a more hop-forward flavor than the lager. Further experiments to target more specific attributes and preferences are recommended.

Introduction

Osborn (2018 and 2021) has invented an improved method of carbonation for craft brewers called the Carbo Rock It. Traditional carbonation, called force carbonation, bubbles CO_2 through beer. Forced carbonation is conducted in a brite tank by injecting CO_2 gas into the beer in the bottom of the tank and the CO_2 bubbles are absorbed as they travel through the beer to the top of the brite tank. If the gas isn't entirely dissolved, it enters the brite tank headspace above the beer. Pressure builds as more gas is added, and eventually the pressure overcomes a pressure relief valve (installed to protect the tank from over pressure damage) at the top of the tank and the CO_2 is released into the atmosphere. The carbonation process can be done very slowly, and most of the gas will be dissolved, or it can be done quickly to increase carbonation rate, but more gas will not dissolve and be wasted. While CO_2 used for carbonation is not typically a major cost to craft brewers, increases in efficiency can save companies money over time. Further, CO_2 is a greenhouse gas, so releasing it will contribute to global warming, and most craft breweries would like to be recognized as "green". Reduced beer flavor and aromatics could be another impact caused by the undissolved gas bubbles absorbing volatiles from the beer and stripping away flavors as it exits the brite tank.

The Carbo Rock-It was created to solve these problems and a prototype of the invention was tested and proven effective in carbonating with no gas losses. However, economic analysis done by Simonson (2020) showed that cost savings from CO_2 alone yielded a payback period of over 4 years. Speculative analysis was done that suggested increasing the cost of beer by even a penny per six pack would allow for a payback period less than two years. To justify this increase, the beer could be marketed as more sustainable because of the reduced carbon emissions. Alternatively, if beer carbonated using the new method could be proven to produce a better sensory experience, consumers may be willing pay more. This research aims to determine whether the latter is possible.

Anecdotal evidence from brewers along with controlled experiments (Clark et al. 2011; Pozo-Bayón et al. 2009) support the hypothesis that released CO_2 carries volatile compounds important to the flavor and aroma of beer. Sensory analysis will be done to determine if there are any perceptible difference between beer carbonated with traditional methods versus beer carbonated with the invention. Additionally, data on which sensory attributes contributed to panelists' choices will be collected. If there is a pattern in these descriptions, future experiments will be recommended to test for specific attributes.

Carbonation

Dissolved CO_2 is an important component of the sensory experience of beer. CO_2 imparts a "sparkle" in beer, and it is able to mask small flavor mistakes (Clark et al. 2011; Langstaff and Lewis 1993). CO_2 is incorporated into beer either by secondary fermentation or directly. Carbonation by secondary fermentation is referred to as natural carbonation whereas the direct addition is called forced carbonation. Natural carbonation is a time-consuming process, requiring days to weeks to complete (Briggs et al. 2004). Additionally, the resulting concentrations of dissolved CO_2 are less predictable and harder to control than with forced carbonation (Briggs et al. 2004). Natural carbonation is used primarily in small scale operations and home brewing.

Forced carbonation relies on the temperature-pressure-concentration relationship that controls the dissolution of gas into a liquid. At a given temperature, the saturated concentration of a gas in a liquid is proportional to the partial pressure of the gas above the liquid. This relationship is credited as Henry's law. Each gas-liquid-temperature pairing has a unique constant associated with the solubility, called Henry's constant. Represented mathematically, the relationship is:

$$X = \frac{P_v}{H} \qquad (1)$$

X = mole fraction of the gas in liquid at equilibrium (moles gas/moles liquid)

P_v = partial pressure of the gas above the liquid (Pa)

H = Henry's constant (Pa/mole gas/mole liquid)

The rate at which the gas is dissolved is positively related to the surface area of the gas-liquid interface. If bubbling gas through a liquid, the smaller the radius of the bubble, the greater the contact area with liquid, and the faster it will dissolve into the liquid. The same is true for spraying liquid through gas; smaller droplets absorb gas faster. This concept is the basis for Osborn's invention.

Method of Invention

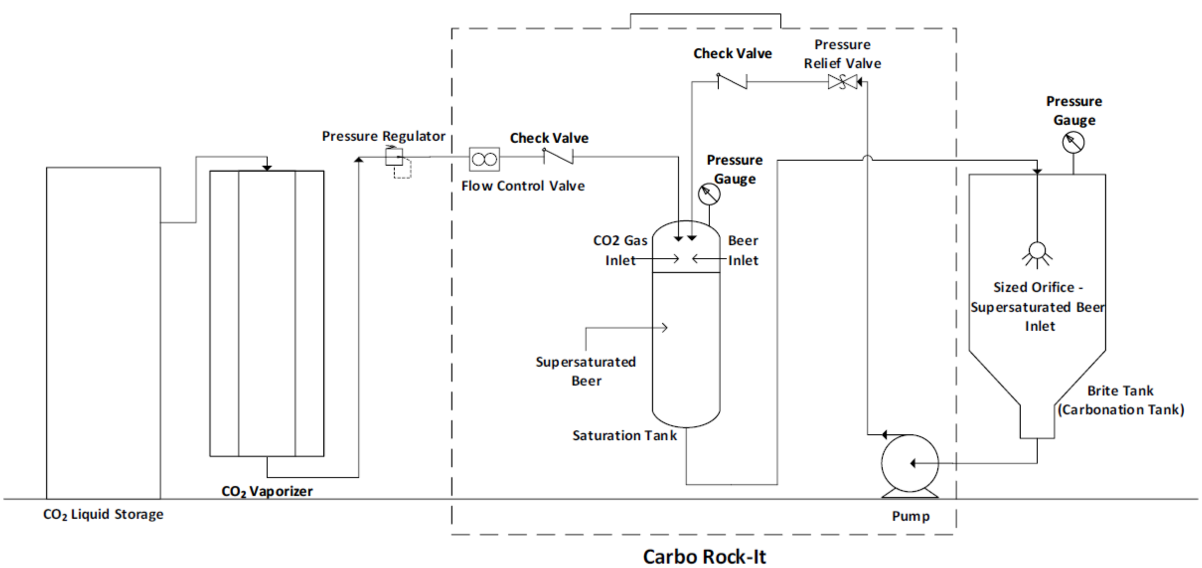

Figure 1: Carbo Rock-It process schematic, Osborn 2021

Osborn's invention leverages Henry's law to create a process in which a portion of the beer is supersaturated with gas and then mixed with the remainder of the beer to carbonate the beer to the desired level. Beer to be carbonated is placed in the brite tank, and a portion of it is pumped to another chamber, called the saturation tank. Here the beer is sprayed through a nozzle down into the tank into which the carbon dioxide gas is being pumped simultaneously. The two mix and the resulting beer containing dissolved CO_2 is carried back to the brite tank. Since the saturation tank is at a greater pressure than the brite tank, the beer is supersaturated with CO_2 when it enters the brite tank and is mixed with the bulk beer. The dissolved CO_2 distributes in the brite tank to subsaturation levels, thereby adding dissolved CO_2 to the bulk beer without bubble rising through it and potentially removing flavor volatiles. This recirculation process is conducted until the desired level of carbonation in the beer in the brite tank is achieved.

Craft Brewing: History and Prominence

In 1965, Fritz Maytag bought the Anchor Brewing Company and revolutionized craft brewing (Elzinga, Tremblay, and Tremblay 2015). Maytag brewed specialty beers such as spiced holiday beers and created the first India Pale Ale, or IPA in America. Recognizing that small scale operations could not match the efficiencies of industrial facilities, Maytag produced beers whose quality and novelty justified a higher price. Maytag was scientifically informed by professor Michael Lewis, and economically informed by Joseph Owades, who proposed large breweries with excess capacity could be leveraged to produce craft beer (Elzinga et al. 2015). By Owades' model, a craft brewer could sell at a discount because of the capital cost savings. Jack McAuliffe saw the potential for craft beers to be paired with food like the wine market at the time. His brewery New Albion, although it only survived six years from 1976 to 1982, stimulated demand for craft beer (Elzinga et al. 2015). Another significant moment in the growth of craft brewing was the publishing of *The Complete Joy of Homebrewing* by Charles Papazian in 1984. The increasing number of homebrewers that transformed into commercial craft brewers created demand for affordable equipment. The emergence and popularity of light beer caused many large breweries to shift their production away from darker, strongly flavored beer, leaving a market for craft and imported beer to fill. The market share of craft beer has increased to 12.3% in 2020 (Brewer's Association 2021) since its inception in 1965 (Elzinga et al. 2015). Craft beer consumers tend to be more wealthy, possibly because increased income leads to demand for variety (Silberberg 1985). Taste is the strongest influence on willingness to pay for craft beer (Gabrielyan et al. 2014), therefore methods which can improve the taste of craft beer should be desirable to craft brewers.

Beer Brewing Process and Flavor Development

The beer brewing process consists of wort preparation, fermentation, maturation, filtering, and packaging. First, cereal grains are mixed with water, and the grains are allowed to germinate. Then, the mixture is kilned, or cooked, which destroys some enzymes and roasts the grains. The extent to which the mash is kilned determines how dark the beer will be. Light beer is kilned for a short period which retains some enzymes that break down the carbohydrates. The cooked grains are then mashed, and the enzymes in the mash convert starches from the grains into fermentable sugars. The liquid portion of the mash, the wort, is then collected (Briggs et al. 2004).

The wort is then boiled with hops to impart flavor. The choice of hop determines the bitterness and other flavors. Fermentation is the next step for the wort. A yeast is chosen to ferment the wort and convert the sugars to ethanol. The choice of yeast determines the type of beer that will be made. An ale uses "top fermenting" yeast which float to the surface, and fermentation occurs in the foam. “Bottom” yeast is used to make a lager, where yeast settle to the bottom of the tank and fermentation occurs there (Briggs et al. 2004). Most aromas and flavors are developed during the fermentation step, particularly aliphatic esters, which are responsible for fruity and flowery flavors (Alves et al. 2020).

After fermentation, the beer is considered “green,” having undesired sulfur-like or sour flavors. To refine the taste, the beer is matured using one or more techniques including adding priming sugars, additional yeast, or wort from the beginning of the process. These additions encourage secondary fermentation, during which the remaining sugars in the beer can be transformed into alcohol and other flavors. Maturation can also include clarification, where suspended particles in the beer are allowed to coagulate and settle. The beer still contains some solids at this point, so it is filtered to create a “bright” beer in which no yeast or other suspended solids remain (Briggs et al. 2004).

The final step before packaging is to add any dissolved gases. In most beers, CO_2 is added. Carbonation creates the “sparkling” mouthfeel of beer, where the consumer feels the tingle of bubble popping in their mouth. Additionally, carbonation adds a slightly acidic taste, as CO_2 reacts with water to form carbonic acid. Carbonation is able to enhance the flavor of beer and make any flavor mistakes less noticeable (Clark et al. 2011; Langstaff and Lewis 1993; McMahon, Culver, and Ross 2017). Some beers are nitrogenated, where nitrogen gas is dissolved in the beer. Nitrogen forms a smaller bubble when it leaves the solution, so the foam it creates is creamier. The mouthfeel of nitrogenated beers is less sharp and smoother than beer that is carbonated because no carbonic acid is formed due to carbonation.

Carbonation and Volatile Release

The hypothesis of this research relies on the idea that as CO_2 bubbles move through the column of beer, volatile aromas and flavors are dissolved into the bubbles, and the volatiles are released into the atmosphere through venting. This idea was established by anecdotal evidence from craft brewers. During forced carbonation, beer aromas are strong near the carbonation tank. There were several sources found indirectly supporting this theory. Pozo-Bayon, et al. (2009) found that increasing carbonation increases the release of aromatic compounds in an artificial throat system. Clark, et al. (2011) found that carbonation and ethanol may have a combined impact that increases in-vivo volatile release. While these experiments didn't directly test the hypothesis, they explain the mechanism by which carbonation affects taste and aroma. By conserving all CO_2 that makes contact the beer, maximum flavors and aromas may be retained in the beer.

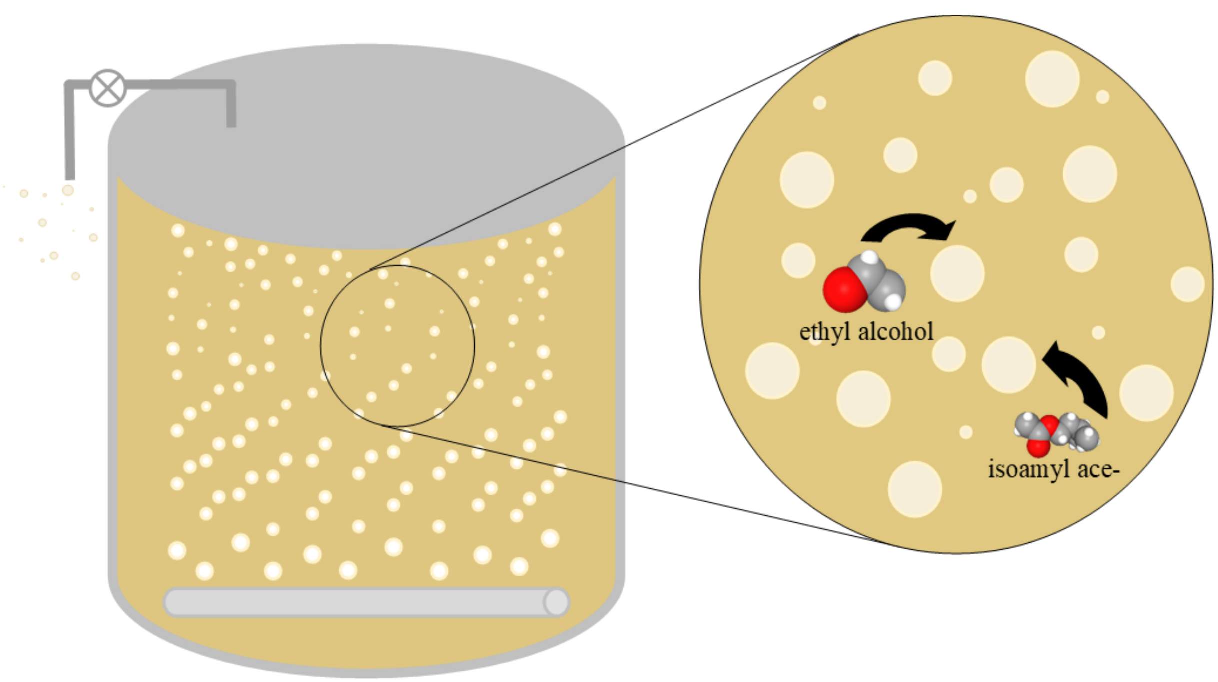

Figure 2: Volatile aromas are absorbed by undissolved gas and consequently stripped from the beer

Materials and Methods

This research will test two types of beer, a lager and an India Pale Ale (IPA). Lagers are bottom fermented in relatively cool conditions and dark in color. IPAs are top fermented, light in color, and tend to have a greater emphasis on hop flavor. Hoppiness was another factor found to be positively correlated with willingness to pay for beer (Gabrielyan et al. 2014), so this type of beer is an ideal candidate. If the IPA carbonated with the invention is perceived as more hoppy, it may be possible to provide justification for an increase in value and therefore, cost.

A batch of IPA and a batch of a lager will be collected from a production batch at Core Brewery made according to their typical process including force-carbonation. These beers will be used as the control. A second production batch will be carbonated using the Carbo Rock-It to carbonate with all other aspects of production being the same as for the control. The Carbo Rock-It beer will be sampled by the brewers as is typical to ensure proper quality. The canned beers will then be labeled and transported for storage at the Food Science Center at the University of Arkansas Division of Agriculture in Fayetteville, Arkansas.

To determine if there is a perceived difference between carbonation methods, a triangle test will be performed for both types of beer. For each test, each participant will be given 3 samples of beer, two of which are carbonated with the same method, while the other is carbonated by the other. This test will be performed by the participant for both varieties of beer. This means that each participant will be given 6 samples in total. The samples will contain approximately 2 oz of beer. The participant will taste each of the samples and choose the sample that they believe is different from the others. The response and whether it is the correct choice will be recorded.

Care will be taken in the preparation of samples to ensure that the only difference in treatments is the carbonation method. Due to equipment and storage limitations, the beers could not be made in the same batch then separated to be carbonated. However, all the same techniques will be used to produce both batches up to the point of carbonation. All samples of the same beer type will be kept in the same storage area so that temperature and light exposure is consistent throughout tests. Additionally, since carbonation release is an important aspect of this study, the three samples in each test should be poured in the same order in which they will be consumed so that the time from pouring to tasting is regular between samples. For both amber lagers and IPAs, beer experts suggest a serving temperature of 45 degrees (WOLINSKI 2018).

The number of panelists necessary depends on the risk levels, sensory difference, and power chosen for the test. There are two types of risk: alpha and beta. The alpha risk is the outcome if the null hypothesis is rejected when it is true in reality. The alpha risk for this study is that the test shows that there is a perceived difference between the beer carbonation methods. The consequence of this is that the brewer believes there is a difference when there is none and consumers will not pay for the difference, and sales are lost. The beta risk is the outcome if the null hypothesis is not rejected when the alternate hypothesis is true. The beta risk for this study is that the test fails to show a difference between the carbonations methods when there actually is one. The consequence of this error would be missing the opportunity to charge more for an improved beer. Since the relative risk of these errors is small and the same, alpha and beta risks of 0.05 will be used. For the sensory difference, or delta (δ), 1.5 standard deviations will be used. A testing power of less than 80% is not considered sufficient but increasing the power will require more panelists. As shown in Table 1, a triangle test using an alpha of 0.05, delta of 1.50, and 90% power required 66 panelists. Therefore, at least 70 panelists will be used in this experiment.

Table 1: Participant count determination (Lawless and Heymann 2010)

Sensory Difference (δ, standard deviations)	2-AFC	Duo-trio	3-AFC	Triangle
80% power				
0.50	78	3092	64	2742
0.75	35	652	27	576
1.00	20	225	15	197
1.25	13	102	9	88
1.50	9	55	6	47
1.75	7	34	5	28
2.00	6	23	3	19
90% power				
0.50	108	4283	89	3810
0.75	48	902	39	802
1.00	27	310	21	276
1.25	18	141	13	124
1.50	12	76	9	66
1.75	9	46	6	40
2.00	7	31	5	26

The proportion of correct responses will be tested using adjusted chi-square (X^2) analysis. The null hypothesis is that the proportion of correct responses is not greater than random chance. Since there are three options, the chance for a participant to randomly choose the right sample is one-third or 33.3%. The factors of the chi square analysis are the expected proportions of correct and incorrect answers and the observed proportions of correct and incorrect answers. Chi-squared is calculated using:

$$X^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad (1)$$

Where:

O_i = the observed value

E_i = the expected value

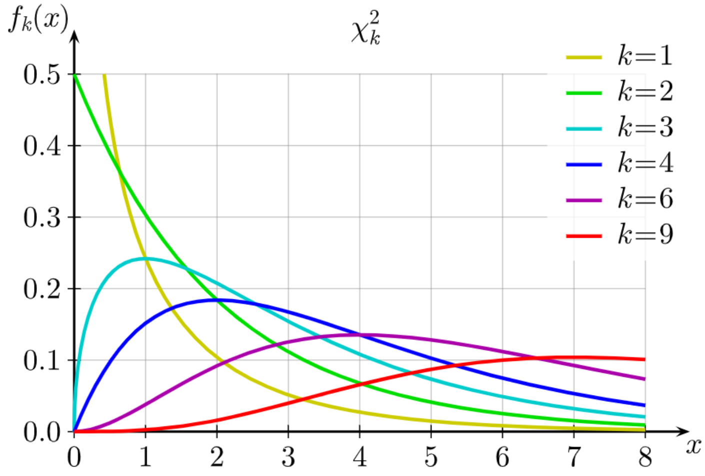

Figure 3: Chi-square distributions by degrees of freedom, k

The expanded chi squared equation for this experiment is shown in Eq. 2. The chi-square distribution of probabilities will be used to determine the probability of the result. Since there are only two factors and two levels being considered, there is one degree of freedom. The minimum chi square value to have 95% confidence that the result is significant for one degree of freedom is 3.84. This value was used for X^2 in Eq. 2 and the number of correct responses needed for a significant result was calculated (see appendix) using the actual number of panelists used, 86. The calculated value for $O_{correct}$ was 37.2. Therefore, if 86 panelists perform a triangle test, and 38 panelists correctly select the different beer, then it can be concluded that the carbonation method creates a perceived sensory difference.

$$X^2 = \frac{(O_{correct} - E_{correct})^2}{E_{correct}} + \frac{(O_{incorrect} - E_{incorrect})^2}{E_{incorrect}} \quad (2)$$

Results

Figure 4: Using the Carbo Rock-It to carbonate a production batch of IPA

The results of the taste tests by the two brewers after carbonation by the Carbo Rock-It were that the IPA was substantially better with more fruity flavor and stronger hoppiness. The lager was perceived by the brewers to be slightly better with more fruity notes. This data is anecdotal, but since the brewers are experiences tasters and the final control point for quality, this information is important to be included here. 86 panelists performed the triangle tests for each type of beer. The results of the triangle test are summarized in Table 2 and Table 4. The built-in statistics formulas in Excel were used to find the p-value. The statistics for the tests are in Table 3 and Table 5. The p-values found for IPA and Lager were 0.00478 and 0.4458 respectively. For the IPA, this value is less than the 0.05 alpha threshold. Therefore, it can be concluded with 95% confidence that there is a significant sensory difference between the IPA force carbonated and the IPA carbonated using the Carbo Rock-It. The lager test p-value is much higher than 0.05. This means that according to the triangle test, there is no significant perceptible difference in the lager force-carbonated and the lager carbonated with the Carbo Rock-It. Any correct responses can likely be attributed to chance.

Table 2: Summary of triangle test results for the IPA

	Expected	Observed	X^2 $(O-E)^2/E$
Correct	28.67	41	5.3062
Incorrect	57.33	45	2.6531

Table 3: Summary of statistics for IPA test

n	86
ΣX^2	7.9593
p	0.00478

Table 4: Summary of triangle test results for the lager

	Expected	Observed	X^2 $(O-E)^2/E$
Correct	28.67	32	0.3876
Incorrect	57.33	54	0.1938

Table 5: Summary of statistics for lager test

n	86
ΣX^2	0.5814
p	0.4458

Conclusions and Discussion

According to the results of the IPA triangle test, the Carbo Rock-It appeared to produce beer that is perceivably different from force carbonated beer. This conclusion matches that of the brewers who concluded that the Carbo Rock-It treated beer was “better” in that it tasted closer to what they aimed to create. The lager had no perceivable difference for the public panel and only a slight difference according to the brewers. Therefore, the impact of the Carbo-Rock It on flavor from these tests seems to depend on the composition of the beer. In these experiments, an IPA and a lager type beer were tested and showed contrasting results. This may have occurred due to the relative strength of the flavors in the types of beer. IPAs have a signature hop flavor that is obvious to the taste. Flavors and aromas in lagers are more subtle. If the Carbo Rock-It retains some percent of the volatile compounds in the beer, the overall impact would be more noticeable if there are more flavor volatiles in the first place, as with the IPA. Alternatively, if the compounds (like the ones responsible for the hop flavor) in the IPA are more volatile than those in the lager, retaining the gas would have a greater impact.

Recommendations for Future Work

While the triangle test conducted is limited to showing a difference, further sensory tests can be conducted to better understand what makes the Carbo Rock-It beer different. For example, a paired comparison test could be conducted to test whether consumers like Carbo Rock-It beer better, as the brewers did, or whether specific flavor or aromatic attributes are stronger in Carbo Rock-It beer. The latter could also be tested by measuring the relative concentrations of certain chemicals. of A descriptive panel is planned for late April 2022. This panel of trained testers will identify the sensory attributes of each of the beers. These tests are worthy of pursuit since it has been proven that there is a perceived difference in at least some instances. If further testing can reveal Carbo Rock-It beer is preferred, this information can be used as a marketing tool to promote the Carbo Rock-It to craft brewers. Otherwise, further testing should at least aim to ensure any differences in flavor the Carbo Rock-It makes will not be unfavorable to consumers. Since craft brewing relies on its beer having unique attributes, retaining subtle flavors and aromas is an appealing benefit of the Carbo-Rock It.

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Appendix A: Chi Square Calculations

$$X^2 = \frac{(O_{correct} - E_{correct})^2}{E_{correct}} + \frac{(O_{incorrect} - E_{incorrect})^2}{E_{incorrect}} \tag{1}$$

$$E_{incorrect} = n - E_{correct} \tag{2}$$

$$O_{incorrect} = n - O_{correct} \tag{3}$$

$$E_{correct} = \frac{n}{3} \tag{4}$$

$$X^2 = \frac{\left(O_{correct} - \frac{n}{3}\right)^2}{\frac{n}{3}} + \frac{\left((n - O_{correct}) - (n - \frac{n}{3})\right)^2}{n - \frac{n}{3}} \tag{5}$$

$$X^2 = \frac{\left(O_{correct} - \frac{n}{3}\right)^2}{\frac{n}{3}} + \frac{\left(n - O_{correct} - \frac{2n}{3}\right)^2}{\frac{2n}{3}} \tag{6}$$

$$X^2 = \frac{\left(O_{correct} - \frac{n}{3}\right)^2}{\frac{n}{3}} + \frac{\left(\frac{n}{3} - O_{correct}\right)^2}{\frac{2n}{3}} \tag{7}$$

$$X^2 = \frac{O_{correct}^2 - \frac{2nO_{correct}}{3} + \frac{n^2}{9}}{\frac{n}{3}} + \frac{\frac{n^2}{9} - \frac{2nO_{correct}}{3} + O_{correct}^2}{\frac{2n}{3}} \tag{8}$$

$$X^2 = \frac{3(O_{correct}^2 - \frac{2nO_{correct}}{3} + \frac{n^2}{9})}{n} + \frac{3(\frac{n^2}{9} - \frac{2nO_{correct}}{3} + O_{correct}^2)}{2n} \tag{9}$$

$$X^2 = \frac{6(O_{correct}^2 - \frac{2nO_{correct}}{3} + \frac{n^2}{9})}{2n} + \frac{3(\frac{n^2}{9} - \frac{2nO_{correct}}{3} + O_{correct}^2)}{2n} \tag{10}$$

$$X^2 = \frac{6\left(O_{correct}^2 - \frac{2nO_{correct}}{3} + \frac{n^2}{9}\right) + 3(\frac{n^2}{9} - \frac{2nO_{correct}}{3} + O_{correct}^2)}{2n} \tag{11}$$

$$X^2 = \frac{6O_{correct}^2 - \frac{12nO_{correct}}{3} + \frac{6n^2}{9} + \frac{3n^2}{9} - \frac{6nO_{correct}}{3} + 3O_{correct}^2}{2n} \tag{12}$$

$$X^2 = \frac{6O_{correct}^2 - 4nO_{correct} + \frac{2n^2}{3} + \frac{n^2}{3} - 2nO_{correct} + 3O_{correct}^2}{2n} \tag{13}$$

$$X^2 = \frac{9O_{correct}^2 - 6nO_{correct} + n^2}{2n} \tag{14}$$

$$n = 86, X^2 = 3.84 \tag{15}$$

$$3.84 = \frac{9O_{correct}^2 - 6(86)O_{correct} + 86^2}{2(86)} \tag{16}$$

$$3.84 = \frac{9O_{correct}^2 - 516O_{correct} + 7396}{172} \tag{17}$$

$$660.48 = 9O_{correct}^2 - 516O_{correct} + 7396 \tag{18}$$

$$0 = 9O_{correct}^2 - 516O_{correct} + 6735.52 \tag{19}$$

The quadratic formula can be used to find the positive solution.

$$O_{correct} = \frac{516 + \sqrt{516^2 - 4(9)(6735.52)}}{2(9)} \tag{20}$$

$$O_{correct} = 37.2 \approx 38\ correct\ answers\ minumum \tag{21}$$

Appendix B: IRB Protocol

Protocol Number:	2001246430	**Expiration Date:**
Investigator:	Han-Seok Seo	**Last Approval Date:**

RazorGrant

Document Overview

Description: Sensory evaluation of beer samples

Explanation: Sensory evaluation of beer samples

Organization Doc Num:

Protocol Summary

Protocol Number: 2001246430

Sequence Number: 0

Status: Submitted to IRB

Expiration Date:

Last Approval Date:

Investigator: Han-Seok Seo

Protocol Details

Type: Exempt

Summary/Keywords:

Application Date: 01/31/2020

Reference Num 1:

Reference Num 2:

FDA Application No:

Title:

Areas of Research Sensory evaluation of beer samples

Code	Description
000001	All Research Areas

Organizations

Type	Organization	Address
Performing Organization	University	University 1125 West Maple Street 210 ADMN Bldg, Fayetteville, AR 72701 USA

Funding Source

Type	Number/Code	Name/Title
Internally Funded/Unfunded Research	N/A	

Protocol Number: 2001246430 **Expiration Date:**

Investigator: Han-Seok Seo **Last Approval Date:**

Subjects

Subject	Count
Adults	5000
UofA Students	5000

Investigators

Person Name: Han-Seok Seo **Role:** Principal Investigator

Units: FDSC Food Science **Affiliation:** Supervisor

Office Phone: 479-575-4778 **Mobile:**

Email: hanseok@uark.edu **Training:** No

Person Name: G. Scott Osborn **Role:** Co-Investigator

Units: BENG Biological and Agricultural **Affiliation:** Faculty

Engineering

Office Phone:	479-575-2877	**Mobile:**	
Email:	gsosborn@uark.edu	**Training:**	No

Person Name:	Kyle J Buffin		**Role:**	Co-Investigator
Units:	FDSC	Food Science	**Affiliation:**	Non-Faculty
Office Phone:	479-575-3845		**Mobile:**	
Email:	buffin@uark.edu		**Training:**	No

Person Name:	Kira Marie Simonson		**Role:**	Co-Investigator
Units:	BAEG	Biological and Agricultural Engineering	**Affiliation:**	Student Investigator
Office Phone:	479-575-3845		**Mobile:**	
Email:	kmsimons@uark.edu		**Training:**	No

Questionnaire

Questionnaire Name: Human Subjects Protocol Interview

Description: Human Subjects Protocol Interview

Module:	IRB	**Sub Module:**	
Protocol Number:	2001246430	**Sequence Number:**	0

Principal Investigator: Han-Seok Seo

Title: Sensory evaluation of beer samples

- What is the purpose of this research? Please explain both why you are doing the research (class assignment, thesis, etc.) AND/OR state your hypothesis. See attachment is not a sufficient response.

This project aims to determine whether consumers can detect any sensory difference between the test beer samples

- Are you collecting data about living individuals?

Yes

- Are you collecting data through intervention or interaction with these individuals?

Yes

- Beyond the basic Participant Types (children, UofA Students, adults, etc.) named elsewhere in this application, do you have a target population (particular group of people) you want to recruit? Some examples might be students in a particular class, members of a particular group or network, people in a specific age range (whether adult or minor), children in a particular school or class, etc.

  No

- How are you recruiting participants? Are you standing in a public place asking people to take a survey, sending out introductory emails, posting an ad or blurb on a website or social media, posting a flyer in a public location, etc.? **Please note that all recruitment materials will need to be uploaded in the Notes and Attachments section.

  Volunteers aged 21 years or older will be recruited via an online survey (http://www.surveymonkey.com) through the University of Arkansas Sensory Service Center Database by emailing the information letter. They will be asked to fill out their demographic profiles prior to their participation. All participants should have 1) no clinical history of major diseases (e.g., cancer, cardiovascular disease, diabetes, etc.), 2) no sensory impairment, and 3) no food allergy or intolerance.

- Provide a brief description of the procedures involving the participants.

  Adults who are eligible to drink beer drinks will be asked to participate in sensory testing of beer samples. There will be three sets of tasting tests. For each set, each participant will be presented with three beer samples (two samples are identical and one is different), and she/he will be asked to select the different sample. The participant will be also asked to describe (or select) the attribute(s) that make(s) different between the test samples. For each sample, 2 oz will be served. There will be a break for 5 min between the test sessions. After completion of this test, a driver will give a ride for each participant.

- How long are the procedures likely to take? Include duration and frequency.

  It will take about 25-30 minutes to complete the session.

- How will information be given to people to get their informed consent to participate in this research? Answers should include specific methods (e.g., verbal consent, information handout, online consent form, full consent form requiring signature documentation.) **Please note that consent materials -- from a script for verbal consent to full consent forms that require participant signature -- must be uploaded in the Notes and Attachments section.

  Full consent form requiring signature documentation

- Does data collection rely on a scheduled event, such as a convention or specific date?

  No

- How will your data be collected? Include all that apply online, on paper/in person, audio and/or video recordings. **Please note that all data collection materials will need to be uploaded in the Notes and Attachments section. This includes: surveys, questionnaires, interview questions or anything that is given to or asked of a participant. Online and/or on paper/in person

- How will your data be stored? Include all that apply: electronically, on paper, audio and/or video recordings.
  Electronically and/or on paper

- How will that data be kept secure?
  Individual responses will be identified only by code numbers (e.g., Participant #001, #002, #003, etc.)., but not by names. All information collected will be kept confidential to the extent allowed by law and University policy. Results from the research will be reported as aggregated data.

- Minimal Risk is defined as risks of harm not greater than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests. Will participants be exposed to more than minimal risk? Include in your consideration the potential of mental risks if asking sensitive questions, or legal or reputational risks in case of breach of confidentiality.
  No

- Are there any direct benefits to the participants for participating in this study?
  Yes

- Describe the benefits participants will or may receive.
  If each participant completes a sensory test session, she/he will receive a Walmart gift card ($15). A driver who gives a ride for each participant will receive a Walmart gift card ($10).

- Will the proposed research involve deception or the withholding of information from participants?
  No

- Will the proposed research necessitate medical clearance from a physician prior to participation?
  No

- Will the proposed research involve gathering biological samples (blood, tissue, etc.)?
  No

- Will the proposed research involve administering of substances or providing food and drink, other than water, to participants?

Yes

- Describe the procedures and safety precautions to be taken in administering substances to participants.

    All food and drink samples presented in this study will be commercially available.

- Will the proposed research involve physical exercise or conditioning?

    No

- Does the research require review by a non-UofA IRB?

    No

- Does this research require approval from another institution or agency, such as a school or privately owned business?

    No

New/Changed Attachments

Description	Last Updated	Updated By
Consent form	01/31/2020 11:24:48	hanseok@uark.edu
Ballot	01/31/2020 11:25:05	hanseok@uark.edu
Recruitment Materials	01/31/2020 11:25:30	hanseok@uark.edu

Actions

Description	Comments	Action Date
Submitted to IRB	Submitted to IRB	01/31/2020
Protocol Created	Protocol created	01/31/2020

Review Comments

Protocol Number:	2001246430	**Sequence Number:**	0
Principal Investigator:	Han-Seok Seo		
Title:	Sensory evaluation of beer samples		
Committee Id:		**Committee Name:**	
Schedule Id:		**Schedule Date:**	

Review Comments: