Hedonic Test of Kombucha Coffee

Raden Nana Kusdiana*, Vinsensius Ferdi, Indra Kusumawardhana, Farah Levyta
Bina Nusantara University, Jl. K.H. Syahdan No. 9, Palmerah, Jakarta 11480, Indonesia
rkusdiana@binus.edu

Abstract. Kombucha is a fermented drink that has a health benefit. Originally, kombucha made from a combination of sweetened tea that mixed with a symbiotic culture of bacteria and yeast to ferment. Moreover, the making of kombucha starts to vary through an infusion method such as herbs infusion, flowers or fruits, and vegetable mixture, and even to substitute with the coffee ground. Indonesia is the fifth largest consumer of coffee in the world. Therefore, this article aims to study an upcycling of leftover coffee grounds to produce kombucha. This form of fermentation method with inoculum Kombucha tea, which then known as Kombucha coffee (KC). The empiric study was conducted using a quantitative method, where a secondary data was supported with the primary result of questionnaires to eighty panelists. The findings of this research suggested that the aroma and taste of KC widely accept by the respondents. Additionally, KC’s aroma, taste, and texture proved more hedonic value than tea kombucha. Although the study has a limitation such as time and the number of respondents. But, the result of the study stimulates a further discussion to investigate the significance of KC towards business and economic benefits.

Keywords: Kombucha, coffee, fermentation, hedonic test

1. Introduction
Consumption of fermented foods and drinks increases to 149% in 2018. This shows developments in the consumption of kombucha, a popular fermented beverage for health-conscious people [1]. Kombucha was originally only made with tea ingredients. But along the way, it was known that any liquid can be the basic ingredient of kombucha as long as it contains sugar. Coffee has a distinctive taste and delicious aroma that differ from other product. Indonesia is the 5th largest coffee consuming country in the world since 282.000 kilogram coffee was consumed throughout Indonesia just in the period of year of 2017 - 2018 [2]. Hence, one of the best ways to make coffee grounds into a high-value product is to turn it into kombucha. Through this upcycling concept, coffee grounds would get a chance to be consumed within the wider community. Consequently, coffee could be fermented with the kombucha culture inoculum. Kombucha culture is not pure culture but is a kind of symbiotic culture between bacteria and yeast. The combination of bacteria and yeast is hereinafter referred to as SCOBY (Symbiotic Culture of Bactery and Yeast) consisting of several bacteria and yeast. The most important bacteria are Acetobacter xilimum and some yeasts that will carry out the fermentation and oxidation processes. The culture will convert sugar into alcohol and produce important substances, including glucuronic acid, acetic acid, lactic acid, vitamins, amino acids and antibiotic substances [3].

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd
The result of the coffee liquid fermentation is called KC, which contains acid content, catechins, alcohol and caffeine. Thus, KC can also be drunk as a healthy drink that follow it predecessor such as KT [4]. Furthermore, based on the empiric study, kombucha based on robusta coffee has the ability to inhibit the growth of Salmonella typhi bacteria [5]. Additionally, other research found that 15% sugar concentration in KC had the highest or most preferred organoleptic value [6].

Therefore, this study aims to determine people's acceptance of KC as a substitute for KT and the level of people's liking between the two such as color, aroma, and taste. The result of the study would benefit to introduce KC to wider market and enhance its economic value.

State of the Art: Based on the research "Chemical and Microbiological Characteristics of Kombucha from Various High Phenol Leaves During Fermentation" conducted by Dwi Wistiana and Elok Zubaidah in 2015, one of the organoleptic analyzes conducted showed that the color of kombucha based on coffee leaves had the most preferred level high compared to kombucha made from tea leaves, bay leaves, soursop leaves, guava leaves, and betel leaves. This is similar to the study of the authors who used coffee grounds as the basis for kombucha [7].

Based on the research "The Effect of Soursop Leaves Kombucha Fermentation Process on Vitamin C Levels" conducted by Irham Falahuddin, Ike Apriani, and Nurfadilah in 2017, vitamin C levels in kombucha are increasing along with the length of fermentation carried out [8].

Based on the research "Antibacterial Effects of Robusta Coffee Fermented with Kombucha on Salmonella typhi" conducted by Romanna Julia Duma Simanjuntak in 2017, kombucha based on robusta coffee has the ability to inhibit the growth of Salmonella typhi bacteria [9].

Based on the research "Effect of Variation Concentration of Sucrose Sugar and Fermentation Time on Kombucha Coffee Making" conducted by Marni Otace Wulan Napitupulu, Setyohadi, and Linda Masniary Lubis in 2015, the more sugar concentrations in kombucha coffee making, the value of the organoleptic taste test will increase as soon as also the longer the fermentation, the value of taste organoleptic test will increase [10].

Based on the research "Antioxidant Activity, Total Phenolic Levels, and Caffeine Levels in Fermented Coffee Kombu Fermentation in Various Sugar Concentrations” conducted by Lusiawati Dewi, Susanti Pudji Hastuti, and Agustian Lucky Silana in 2014, 15% sugar concentration in coffee kombucha had the highest or most preferred organoleptic value [11].

Organoleptic Test and pH Changes of Kombucha Palm Sugar Beverage from Different Types of Coffee which are affected by Fermentation Time. This research from the Journal of Pharmacy and Science draws the conclusion that coffee-based kombucha experiences an increase in pH and a decrease in organoleptic value of taste, color, and aroma as long as fermentation [12].

Study on the Use of Toraja Coffee as Kombu Fermentation Media. This study draws the conclusion that coffee solution can be used as a medium for making kombucha. The percentage of dilution of coffee to water also affects the organoleptic value of taste, color, and aroma. Dilution of 8.5 grams of fresh coffee (not coffee grounds) per 250ml of water is most preferred [13].

Effects of Medium Variation and Fermentation Time on the Antioxidant and Antimicrobial Properties of Kombucha. This research from the Malaysian Journal of Fundamental and Applied Sciences draws the conclusion that the antioxidant content in kombucha made from tea has decreased when entering the 7th day of fermentation [14].

Enhancement of the Functional Properties of Coffee Through Fermentation by "Tea Fungus" (Kombucha). This research from the Journal of Food Processing and Preservation draws the conclusion that there is chemical evidence of increased levels of antioxidants and amylase enzymes in coffee fermented into kombucha [15].
Consumer Acceptability of a Kombucha Coffee Prototype with Traditional Coffee Characteristics. This previous study draws the conclusion that aroma is the most preferred characteristic with the highest value in the sensory evaluation of coffee-based kombucha [4].

2. Experimental method

This study uses experimental research methods to obtain the effect of a particular treatment on others under controlled conditions [16]. In this case the treatment given is substitution of basic ingredients kombucha using coffee grounds and testing the level of preference for kombucha made from tea.

Sensory evaluation is a scientific method of product evaluation using the five senses consisting of the mouth as a taste appraiser, the nose as an aroma appraiser, and the eyes as a color and appearance evaluator. This study uses affective testing in which the type of research is in the form of preference or hedonic tests for panelists who do not need to be trained [17].

In this study the population used was active students at Bina Nusantara University. Population is defined as the area of generalization of objects or subjects that have certain characteristics and qualities to be studied and conclusions are determined [16]. The sampling technique used is simple random sampling where the sampling of members of the population is carried out randomly without regard to strata in the population [16]. The number of untrained panelists used as a sample of this study is based on the recommendations of the Committee on Sensory Evaluation of the Institute of Food Technologist, which is 80 people for preference tests [18].

The authors use the scale measurement sensory rating of six hedonic scale to determine the level of panelist preference for kombucha products. The scale is composed of numerical numbers 1 to 6 that indicate the response information (1) Dislike, (2) Neutral, (3) Rather like, (4) Like, (5) Really like, and (6) Very like. The panelists’ personal evaluation of a number of those determined in the study sample was collected by means of the questionnaires. The numerical data collected is then processed using statistical analysis instruments so that differences in the value of the final product can be obtained [18]. Statistical Descriptive Analysis is a way of describing or describing data that has been collected as it is without making generally accepted conclusions or generalizations. This analysis is used to describe the sample data, not to make conclusions that apply to the entire population [16]. Additionally, Paired sample T test is conducted. This is a comparative analysis between two samples that have correlations. Comparative analysis (difference) means the analysis used to find out the difference between two variables (data). Paired sample T test decision making is based on the probability value (sig) of the calculation with SPSS. If the probability value (sig) is greater than the significant level (α) then the null hypothesis (Ho) is accepted. Conversely, if the probability value (sig) is smaller than the significant level (α) then the null hypothesis is rejected [19].

3. Results and discussion

3.1. Descriptive Frequency Analysis

Table 1 display the information as follow. In the color frequency of sample A, as many as 1.3% (1 panelist) chose dislike, 16.3% (13 panelists) chose neutral, 18.8% (15 panelists) chose rather like, 42.5% (34 panelists) chose like, 10% (8 panelists ) chose really like, and 11.3% (9 panelists) voted very like. So that the biggest frequency is 42.5% showing likeness to the color of kombucha with the basic ingredients of tea. Thus, in the frequency of aroma sample A, as many as 13.8% (11 panelists) chose dislike, 28.8% (23 panelists) chose neutral, 22.5% (18 panelists) chose rather like , 21.3% (17 panelists) chose like, 10% (8 panelists ) chose really like, and 3.8% (3 panelists) voted very like. So that the biggest frequency is 28.8% showing neutral to the flavor of kombucha with the basic ingredients of tea. Hence, in the sample taste frequency A, 30% (24 panelists) chose dislike, 20% (16
Panelists) chose neutral, 20% (16 panelists) chose rather like, 18.8% (15 panelists) chose like, 8.8% (7 panelists) chose really like, and 2.5% (2 panelists) voted very like. So that the biggest frequency is 30% showing dislike of the taste of kombucha with the basic ingredients of tea.

Table 1. Kombucha uses tea (Sample A).

| Frequency   | Color | Flavor | Taste | Percent | Valid Percent | Cumulative Percent |
|-------------|-------|--------|-------|---------|---------------|--------------------|
| Dislike     | 1     | 11     | 24    | 1.3     | 13.8          | 30.0               |
| Neutral     | 13    | 23     | 16    | 16.3    | 28.8          | 50.0               |
| Rather      |       |        |       |         |               |                    |
| Like        | 15    | 18     | 16    | 18.8    | 22.5          | 30.0               |
| Like        | 34    | 17     | 15    | 42.5    | 21.3          | 70.0               |
| Very        |       |        |       |         |               |                    |
| Like        | 8     | 8      | 7     | 10.0    | 10.0          | 12.5               |
| Like        | 9     | 3      | 2     | 11.3    | 3.8           | 15.0               |
| Total       | 80    | 80     | 80    | 100     | 100           | 100                |

Table 2. Kombucha uses coffee grounds (Sample B).

| Frequency   | Color | Flavor | Taste | Percent | Valid Percent | Cumulative Percent |
|-------------|-------|--------|-------|---------|---------------|--------------------|
| Dislike     | 6     | 12     | 10    | 7.5     | 12.5          | 12.5               |
| Neutral     | 10    | 12     | 10    | 12.5    | 15.0          | 25.0               |
| Rather      |       |        |       |         |               |                    |
| Like        | 17    | 12     | 15    | 18.8    | 15.0          | 43.8               |
| Like        | 25    | 23     | 25    | 31.3    | 28.8          | 75.0               |
| Very        |       |        |       |         |               |                    |
| Like        | 15    | 19     | 12    | 18.8    | 23.8          | 90.0               |
| Like        | 7     | 8      | 8     | 10.0    | 10.0          | 100                |
| Total       | 80    | 80     | 80    | 100     | 100           | 100                |

Table 2 display the information as below. In the color frequency of sample B, as much as 7.5% (6 panelists) chose dislike, 12.5% (10 panelists) chose neutral, 21.3% (17 panelists) chose rather like, 31.3% (25 panelists) chose like, 18.8% (15 panelists) chose really like, and 8.8% (7 panelists) chose very like. So that the biggest frequency is 31.3% showing likeness to the color of kombucha with coffee grounds. Moreover, in the scent frequency of sample B, 7.5% (6 panelists) chose dislike, 15% (12 panelists) chose neutral, 15% (12 panelists) chose rather like, 28.8% (23 panelists) chose like, 23.8% (19 panelists) chose really like, and 10% (8 panelists) voted very like. So that the biggest frequency is 28.8% showing likeness to the flavor of kombucha with coffee grounds. Furthermore, in the sample taste frequency B, 12.5% (10 panelists) chose dislike, 12.5% (10 panelists) chose neutral,
18.8% (15 panelists) chose rather like, 31.3% (25 panelists) chose like, 15% (12 people) chose really like, and 10% (8 panelists) voted very like. So that the biggest frequency is 31.3% showing the taste of kombucha with coffee grounds.

3.2 Statistical Descriptive Analysis

**Table 3. Statistical Descriptive Analysis.**

|                      | N  | Minimum | Maximum | Mean  | Std. Deviation |
|----------------------|----|---------|---------|-------|----------------|
| Color A              | 80 | 1       | 6       | 3.78  | 1.211          |
| Color B              | 80 | 1       | 6       | 3.68  | 1.357          |
| Valid N (listwise)   | 80 |         |         |       |                |
| Flavor A             | 80 | 1       | 6       | 2.96  | 1.345          |
| Flavor B             | 80 | 1       | 6       | 3.76  | 1.425          |
| Valid N (listwise)   | 80 |         |         |       |                |
| Taste A              | 80 | 1       | 6       | 2.64  | 1.434          |
| Taste B              | 80 | 1       | 6       | 3.54  | 1.475          |
| Valid N (listwise)   | 80 |         |         |       |                |

The table above on statistical descriptive analysis prove the information as below. In term of descriptive color statistics between tea-based kombucha (Color A) and coffee grounds-based kombucha (Color B), the average value of color A was 3.78 and color B was 3.68. This tells the data that panelists prefer the color of KT with an average difference of 0.1. Both have a minimum value of 1 (dislike) and a maximum of 6 (very, very like). On the descriptive statistics of flavor from tea-based kombucha (Flavor A) with kombucha made from coffee grounds (Flavor B), the average flavor value of A was 2.96 and the flavor of B was 3.76. It shows that the community prefer the flavor of KC with an average difference of 0.8. Both have a minimum value of 1 (dislike) and a maximum of 6 (very like). Moreover, the descriptive statistics of taste from tea-based kombucha (Taste A) against kombucha made from coffee grounds (Taste B) shows the average value of taste A was 2.64 and taste B was 3.54. These prove that community preferred the taste of KC with an average difference of 0.9. Both have a minimum value of 1 (dislike) and a maximum of 6 (very like).

**Table 4. Paired Sample T Test.**

| Pair   | Paired Differences | t      | df  | Sig. (2-tailed) |
|--------|--------------------|--------|-----|-----------------|
| 1      | Color A – Color B  | .100   | 1.506 | .168            |
| 2      | Flavor A – Flavor B| -1.800 | 1.504 | .168            |
| 3      | Taste A – Taste B  | -1.900 | 1.620 | .181            |
| 4      | Total A – Total B  | -2.200 | 3.865 | .432            |

The results of the paired sample T test show that there is a significant difference in color, flavor, and taste between tea-based kombucha and coffee grounds-based kombucha.
Table 4 above present the result of the calculation of the paired sample T test whose decision making is based on the probability value (sig). In the color indicator, the probability value (sig) is greater than the significant level (α), so the null hypothesis is accepted (0.554 (sig) > α). While in the flavor indicator, the probability value (sig) is smaller than the significant level (α), so the null hypothesis is rejected (0.000 (sig) < α). Thus, the taste indicator, the probability value (sig) is smaller than the significant level (α), so the null hypothesis is rejected (0.000 (sig) < α).

Table 5. Results of Kombucha Tea Assessment.

| Color  | Flavor | Taste |
|--------|--------|-------|
| Dislike| 1      | 11    |
| Neutral| 13     | 23    |
| Like   | 15     | 18    |
| Really Like | 34 | 17    |
| Very Like | 8    | 8     |
| Like   | 9      | 3     |
| Total  | 80     | 80    |

| Color  | Flavor | Taste |
|--------|--------|-------|
| Dislike| 6      | 6     |
| Neutral| 10     | 12    |
| Like   | 17     | 12    |
| Really Like | 25 | 23    |
| Very Like | 15    | 19    |
| Like   | 7      | 8     |
| Total  | 80     | 80    |

On the result of Kombucha Tea Assessment, the table shows the data as follow. The color of KT, 1 panelist chose dislike, 13 panelists chose neutral, 15 panelists chose rather like it, 34 panelists chose to like, 8 panelists chose really like, and 9 panelists chose very like. Therefore, panellists like KT’s colour. Moreover, towards the flavor of kombucha using tea, 11 panelists chose dislike, 23 panelists chose neutral, 18 panelists chose rather like it, 17 panelists chose to like, 8 panelists chose really like, and 3 panelists chose very like. So that the scale most chosen is neutral to the scent of KT. Thus, in term of the taste of kombucha using tea, 24 panelists chose dislike, 16 panelists chose neutral, 16 panelists chose rather like it, 15 panelists chose like, 7 panelists chose really like, and 2 panelists chose very like. So, the panellist do not like the taste of KT.

On the other hand, the result of Kombucha using coffee grounds Assessment display the information as follow. The color of kombucha using coffee grounds presents 6 panelists chose dislike, 10 panelists chose neutral, 17 panelists chose rather like it, 25 panelists chose like, 15 panelists chose really like, and 7 panelists chose very like. So, the community is like the color of KC. On the test of the flavor of kombucha using coffee grounds, 6 panelists chose dislike, 12 panelists chose neutral, 12 panelists chose rather like it, 23 panelists chose like, 19 panelists chose really like, and 8 panelists chose very like. Therefore, the community accept the flavor of KC. Finally, the taste of kombucha using coffee grounds prove that 10 panelists chose dislike, 10 panelists chose neutral, 15 panelists chose rather like it, 25 panelists chose like, 12 panelists chose really like, and 8 panelists chose very like. This means the community like the taste of KC.

4. Conclusion
Based on the results of the paired sample T test, it can be concluded that the color of kombucha made from coffee grounds is not acceptable to the community. But, the flavor and the taste of kombucha made from coffee grounds were acceptable.
Additionally, based on the results of the statistical descriptive analysis test, the level of preference on color indicators for tea-based kombucha with an average value of 3.78 is more preferable than coffee-based kombucha with an average value of 3.68. Whist, the level of preference on aroma indicators for kombucha based coffee grounds with an average value of 3.76 is more liking by the community rather than kombucha made from tea (average value of 2.96). Furthermore, the level of preference towards flavor indicators, for kombucha based on coffee grounds with an average value of 3.54 prevails kombucha made from tea with an average value of 2.64.

Therefore, based on data, whereas the colour of Kombucha based on coffee grounds is darker, the community prefer the color of Kombucha based on tea, which is light brown. But on the Flavor and Taste indicator, panelists prefer Kombucha based on coffee grounds than tea based Kombucha. This is because the community likes the flavor and taste of coffee-based Kombucha that is stronger and delicious than tea-based Kombucha.

**References**

[1] L. Saxe, “Fermented foods are up 149% - as long as they’re unfamiliar”, Forbes.com, February 6, 2019. [Online]. Available: https://www.forbes.com/sites/lizzysaxe/2019/02/06/fermented-foods-are-up-149-percent-as-long-as-theyre-unfamiliar [accessed June 22, 2019]

[2] International Coffee Organization, “World Coffee Consumption”, 2019. [Online]. Available: http://www.ico.org/prices/new-consumption-table.pdf [accessed June 22, 2019]

[3] World Health Organization, “2018 Health SDG Profile: Indonesia”, 2018. [Online]. Available: http://www.searo.who.int/entity/health_situation_trends/cp_ino.pdf [accessed June 22, 2019]

[4] Lin. L M “Consumer Acceptability of a Kombucha Coffee Prototype with Traditional Coffee Characteristics.” Family and Consumer Science, 2017, p 81. [Abstract]. Available: ProQuest https://pqdtopen.proquest.com/ [accessed November 13, 2019]

[5] R. J. D. Simonjuntak, *Effect of Variation Concentration of Sucrose Sugar and Fermentation Time on Kombucha Coffee Making*, Bandar Lampung: Medical Education, Faculty of Medical, University of Lampung, 2017

[6] L. Dewi, S. P. Hastuti and A. L. Silana, *Antioxidant Activity, Total Phenolic Levels, and Caffeine Levels in Fermented Robusta Coffee Combo in Various Sugar Concentrations*, 2015

[7] D. Wistiana, and E. Zubaidah, “Journal of Food and Agro-Industry”, *Chemical and Microbiological Characteristics of Kombucha from Various High Phenol Leaves During Fermentation*, Vol. 3(4), pp. 1446-1457, 2015.

[8] I. Falahuddin, I. Apriani, and Nurfadilah, “Biota Journal”, *Effect of Soursop Leaf Kombucha Fermentation Process on Vitamin C Levels*, Vol. 3(2), pp. 90-95, 2017

[9] R. J. D. Simonjuntak, *Effect of Variation Concentration of Sucrose Sugar and Fermentation Time on Kombucha Coffee Making*, Bandar Lampung: Medical Education, Faculty of Medical, University of Lampung, 2017

[10] M. O. W. Napitupulu, Setyohadi, and L. M. Lubis, “Journal of Food and Agriculture Engineering”, *Effect of Variation Concentration of Sucrose Sugar and Fermentation Time on Kombucha Coffee Making*, Vol. 3(3), pp. 316-322, 2015

[11] L. Dewi, S. P. Hastuti, and A. L. Silana, “National Microbiology Seminar Paper “, *Antioxidant Activity, Total Phenolic Levels, and Caffeine Levels in Fermentation of Robusta Coffee Combo in Various Sugar Concentrations*, 2014

[12] K. A. P Lestari, Surahmaid, R. Darmawan, and L. Sadiyah,”Journal of Pharmacy and Science”, *Organoleptic test and change in pH of kombucha palm coffee drinks from various types of coffee that are affected by the fermentation time*, Vol. 4(1), pp. 15-18, 2019

[13] E. M. Marampa, Study on the Use of Toraja Coffee as Kombu Fermentation Media. Salatiga: Universitas Kristen Satya Wacana, 2019

[14] B. M. Vohra, S. Fazry, F. Sairi, and O. Babul-Airianah, “Malaysian Journal of Fundamental and Applied Sciences”, *Effects of medium variation and fermentation time on the antioxidant and antimicrobial properties of kombucha*, pp. 298-302, 2019
[15] M. I. Watawana, N. Jayawardena, and V. Y. Waisundara, “Journal of Food Processing and Preservation”, Enhancement of the functional properties of coffee through fermentation by “tea fungus” (kombucha), Vol. 39, pp. 2596-2603, 2015
[16] Sugiyono, Quantitative, Qualitative, and R&D Research Methods, Bandung: Alfabet, 2017
[17] I. S. Surono, P. Waspodo and B. S. Abbas, New Product Research and Development, Jakarta: Binus Media & Publishing, 2015
[18] D. R. Adawiyah, B. Nurtama, D. Herawati, D. Indrasti and E. Syamsir, Sensory Evaluation. Publication of Limited Circulation, 2015
[19] F. J. Gravetter and L. B. Forzano Research Methods for the Behavioral Sciences, Canada: Nelson Education, 2015