

## THE EFFECT OF THE PROPORTION OF PINEAPPLE SKIN AND APPLE TEA ON THE CHEMICAL AND ORGANOLEPTIC CHARACTERISTICS OF KOMBUCHA

Sholikha Amalia Putri<sup>1\*</sup>, Kejora Handarini<sup>2</sup>, Adhania Andika Prayudanti<sup>3</sup>, Andreas Alvin<sup>4</sup>

Faculty of Food and Fisheries Technology / Dr. Soetomo University, Surabaya <sup>1,2,3,4</sup>

E-mail: [sholikhaamaliaputri@gmail.com](mailto:sholikhaamaliaputri@gmail.com)<sup>1</sup>, [kejora.handarini@unitomo.ac.id](mailto:kejora.handarini@unitomo.ac.id)<sup>2</sup>, [adhania@unitomo.ac.id](mailto:adhania@unitomo.ac.id)<sup>3</sup>,  
[Alvinwibisono@yahoo.co.id](mailto:Alvinwibisono@yahoo.co.id)<sup>4</sup>

Received : 01 January 2026

Accepted : 17 February 2026

Revised : 15 January 2026

Published : 28 February 2026

### Abstract

Pineapple peel contains flavonoids and acids, while apple tea is rich in polyphenols and tannins that can increase the functional value of fermented products. The purpose of this study was to determine the effect and determine the best ratio of pineapple peel with apple tea on the chemical and organoleptic properties of kombucha drinks. The study was conducted quantitatively experimentally using a completely randomized design (CRD) with one factor, namely the ratio of pineapple peel and apple tea in making kombucha, with four treatments: P1 (0%:100%), P2 (25%:75%), P3 (50%:50%), and P4 (75%:25%). Fermentation took place for seven days at room temperature (25–30°C). The chemical parameters tested included pH, total titratable acid, total dissolved solids, and total phenolic content, analyzed using Analysis of Variance (ANSIRA) and continued with the Least Significant Difference (LSD) test if there was a significant difference. Organoleptic tests were conducted using the hedonic method for color, aroma, and taste, using the Kruskal–Wallis non-parametric analysis. The results showed that treatment P2 (25% pineapple peel : 75% apple tea) provided the best chemical and organoleptic characteristics. Increasing the proportion of pineapple peel decreased pH and phenolic content and increased total acid and total soluble solids, while the proportion of apple tea produced an optimal balance between chemical and organoleptic properties, including preferred color, aroma, and taste. This indicates that the 25%:75% combination has great potential as an optimal formulation for making kombucha with balanced chemical and organoleptic characteristics.

**Keywords :** *kombucha, pineapple peel, apple tea*

### INTRODUCTION

Kombucha is a traditional fermented beverage produced by inoculating a Symbiotic Culture of Bacteria and Yeast (SCOBY) into sweet tea. It is popular for its distinctive flavor and various health benefits, including antioxidant activity, digestive health, improved immunity, and cholesterol-lowering effects (Ojo & de Smidt, 2023). Kombucha's popularity is growing globally, with the market estimated to reach over USD 3.5 billion by 2025 (Kim et al., 2022). This situation indicates the potential for developing alternative kombucha-based ingredients with high functional value. One potential ingredient is pineapple peel (*Ananas comosus* L. Merr.) , which has long been considered a waste product from the fruit industry. Kombucha made from pineapple peel showed an increase in antioxidant activity from 58.2% to 74.6% after 10 days of fermentation, with a total phenol content of 156.84 mg GAE/L (Budiandari et al., 2023). The bioactive components of pineapple peel, such as flavonoids, ascorbic acid, and the enzyme bromelain, play a role in the formation of organic acids during fermentation (Huey et al., 2025). Utilizing pineapple peel not only has economic value but also helps reduce organic waste. Furthermore, apple tea (*Malus domestica*) also has potential as a kombucha substrate. Apple tea contains polyphenols, tannins, and flavonoids, which act as natural antioxidants (Halim et al., 2025). Previous research has shown that various fruits and their derivatives, such as guava, pineapple, butterfly pea flower, and apple, can increase the total phenol content and antioxidant activity of kombucha (Zubaidah et al., 2023; Anwar et al., 2024; Muchlisun et al., 2023; Rosita et al., 2021). In addition to chemical aspects, variations in the concentration of the main ingredients and sugar also affect sensory characteristics, with the highest preference level at 100 g/L sugar and 15% starter (Siregar et al., 2023).

This study aims to determine the effect of the ratio of pineapple peel and apple tea on the chemical and organoleptic properties of kombucha and to determine the best ratio that produces the most optimal kombucha characteristics.

## **LITERATURE REVIEW**

### **Pineapple Skin**

Pineapple peel (*Ananas comosus L. Merr.*) is a fruit processing waste that has significant nutritional value and bioactive compounds, including carbohydrates, dietary fiber, vitamin C, phenolics, flavonoids, tannins, and ascorbic acid (Hikal et al., 2021; Fauzi et al., 2023). Simple sugars in pineapple peel act as a carbon source for fermentative microbes, supporting the growth of *Acetobacter xylinum* and yeast, and increasing organic acid production during kombucha fermentation (Huey et al., 2025). Dietary fiber acts as a prebiotic that supports the activity of probiotic microbes. Pineapple peel also contains the enzyme bromelain and calcium oxalate, which can cause mild irritation, but heating and filtration effectively reduce this risk (Nelson et al., 2022; Cano-Lamadrid & Artés-Hernández, 2022). Previous studies have shown that fermented kombucha made from pineapple peel increases total antioxidant and phenolic activity, and is safe for consumption after heating and filtering (Budiandari et al., 2023; Huey et al., 2025).

### **Apple Tea**

Apple tea (*Malus domestica*) is rich in polyphenols, flavonoids, and vitamin C, which act as antioxidants (Halim et al., 2025; Muchlisun et al., 2023). The natural sugars in apples provide a carbon source for kombucha fermentation, support SCOBY growth, and produce organic acids that impart a distinctive flavor (Rosita et al., 2021). Combining apple juice with spices or herbal teas can enhance the beverage's antioxidant activity and sensory acceptability (Cardoso de Souza et al., 2020; Zubaidah et al., 2018). Previous research has shown that apple kombucha maintains its antioxidant profile and flavor when used as a functional ingredient (Halim et al., 2025).

### **Kombucha**

Kombucha is a fermented sweet tea beverage made with a SCOBY, producing organic acids, vitamins, and bioactive compounds (Jakubczyk et al., 2020). The fermentation process involves the conversion of sucrose to glucose and fructose by yeast, followed by the oxidation of ethanol by acetic acid bacteria to acetic acid and other organic acids, resulting in a low pH and a characteristic sour taste (Jayabalan et al., 2014; Nyhan et al., 2022). Kombucha contains B-complex vitamins, phenolics, and volatile compounds that contribute to its antioxidant activity and sensory characteristics (Villarreal-Soto et al., 2018).

### **Ingredients for Making Kombucha**

The main ingredients of kombucha include SCOBY, starter, sugar, and water. SCOBY consists of acetic acid bacteria (*Komagataeibacter xylinus*) and yeast (*Saccharomyces*, *Brettanomyces*, *Zygosaccharomyces*), which play a role in the conversion of sugars into organic acids, ethanol, and bioactive compounds (Nyhan et al., 2022; Liao et al., 2024; Ojo & de Smidt, 2023). The starter initiates fermentation and lowers the initial pH of the medium (Kitwetcharoen et al., 2023). Sugar serves as the primary carbon source and influences the phenolics, antioxidant activity, viscosity, and carbonation of the final product (Ojo & de Smidt, 2023; Kitwetcharoen et al., 2023). Water as a fermentation medium must have a neutral pH and moderate mineral content to support microbial activity (Nyhan et al., 2022; Liao et al., 2024).

### **Chemical Analysis**

The main parameters for chemical analysis of kombucha include pH, total acid, total dissolved solids (TDS), and phenolic content. A decrease in pH and an increase in total acid reflect the metabolic activity of acetic acid bacteria, while TDS indicates the conversion of sugars into metabolites (Jakubczyk et al., 2020; De Oliveira et al., 2020; Zubaidah et al., 2023). Total phenolic content is an indicator of antioxidant activity and the functional value of the product (Kitwetcharoen et al., 2023).

### **Organoleptic Test**

Organoleptic testing assesses panelists' preference for kombucha color, aroma, and flavor, as well as the effect of treatment on consumer acceptance (Kitwetcharoen et al., 2023; Tran et al., 2022). The fermentation

process influences volatile compounds, organic acids, and phenolics, which form distinctive sensory characteristics (Haug et al., 2023).

## RESEARCH METHODS

This research was conducted at the Food Processing Laboratory, Food Technology Study Program, Dr. Soetomo University. in November to December 2025. The main ingredients used are pineapple peel and apple tea obtained through online purchases from D hilanmesindo, while SCOBY was also purchased from the BYSIA online store and supporting materials such as water and sugar were obtained from the Alfamidi store located at Jl. Dukuh Kupang XXV, Dukuh Pakis District, Surabaya. For chemical analysis, aquades solution, NaOH, buffer solution, and H<sub>2</sub>SO<sub>4</sub> were used. The tools used include glass jars, digital scales, filters, pans, stoves, spoons, cloth/tissue, digital pH meters, burettes, volume pipettes, Erlenmeyer flasks, phenolphthalein indicators, refractometers, UV-Vis spectrophotometers, micro pipettes, and test tubes.

The method applied was a quantitative laboratory experiment, which aims to test the causal relationship between variables through certain treatments under controlled conditions. This approach allows for observation of the effect of independent variables on dependent variables with control of external factors so that conclusions can be obtained objectively and measurably (Syafri, 2022). The research design used was a one-factor Completely Randomized Design (CRD) with four treatments, namely P1 (pineapple peel: apple tea = 0% : 100%), P2 (25% : 75%), P3 (50% : 50%), and P4 (75% : 25%), each repeated three times. The CRD was chosen because it is simple, efficient, and provides maximum degrees of freedom for experimental error, so that the estimation results are more accurate (Usman et al., 2022). The research phase included the preparation of kombucha based on a modified procedure by Budiandari et al. (2023). Pineapple peel was washed, cut, and blanched in boiling water for one minute, then boiled with apple tea and sugar to extract the active compounds. The solution was filtered, transferred to a sterile glass jar with mineral water, and then cooled to approximately 30°C. The starter and SCOBY were slowly added, and fermentation took place for seven days at room temperature (25–30°C) with a gauze cover. After fermentation, the SCOBY was removed and the kombucha was filtered again before being stored in a closed container at a cool temperature of ±4°C. The formulation of ingredients for each treatment was adjusted according to the proportions of pineapple peel and apple tea, while the sugar, water, starter, and SCOBY remained constant.

The variables observed included pH (SNI 6989.11:2019), total acid through 0.1 N NaOH titration with phenolphthalein indicator (SNI 01-2891-1992), total dissolved solids (TPT) using a refractometer in °Brix, total phenolic content using the Folin-Ciocalteu method, and organoleptic attributes such as color, aroma, and taste assessed by 30 semi-trained panelists using a hedonic scale of 1–5 (Mehran, 2015). Data were analyzed statistically using ANSIRA with the help of SPSS version 24. If there was a significant difference with a Coefficient of Variance (CC) <5%, the Least Significant Difference (LSD) test was continued; if the CC was 5–10%, the Honestly Significant Difference (HSD) test was used, while if the CC >10%, the Duncan test was used (Siregar et al., 2023). For non-parametric data such as organoleptic tests, the Kruskal–Wallis test was used to determine significant differences between treatments (Halim et al., 2025).

## RESULTS AND DISCUSSION

### 1. Chemical Test

#### pH test

Presenting the average pH results of kombucha made from pineapple peel (*Ananas comosus L. Merr.*) and apple tea (*Malus domestica*) with different treatment comparisons, which have an effect on the pH value of kombucha.

**Table 1. Average pH results of Kombucha**

Pineapple Skin : Apple Tea	Average (%)
P 1 ( 0% : 100%)	3 , 6200 ± 0 , 088 <sup>c</sup>
P2 ( 2.5 % : 7.5 %)	3 , 5767 ± 0 , 025 <sup>bc</sup>
P3 ( 50 % : 50 %)	3 , 4633 ± 0 , 015 <sup>ab</sup>
P4 ( 7.5 % : 2.5 %)	3 , 4100 ± 0 , 020 <sup>a</sup>

The analysis of variance results showed a significant value ( $p < 0.05$ ), indicating that the difference in the ratio of pineapple peel and apple tea significantly affected the pH of kombucha. The pH value decreased as the proportion of pineapple peel increased, with the highest pH at P1 (3.6200) and the lowest at P4 (3.4100), while P2 and P3 were in between (3.5767 and 3.4633). This decrease in pH was caused by the increased formation of

# THE EFFECT OF THE PROPORTION OF PINEAPPLE SKIN AND APPLE TEA ON THE CHEMICAL AND ORGANOLEPTIC CHARACTERISTICS OF KOMBUCHA

Sholikha Amalia Putri et al

organic acids during fermentation, where sugars were fermented by yeast into ethanol which was then oxidized by acetic acid bacteria into organic acids (Villarreal-Soto et al., 2018). The use of pineapple peel as a fermentation substrate was known to produce a lower pH than tea, because its sugar content supports acid production during fermentation (Phung Tu Ly et al., 2023).

## Total Acid

Presenting the average total acid results of kombucha made from pineapple skin (*Ananas comosus* L. Merr.) and apple tea (*Malus domestica*) with different treatment ratios, which have an effect on the total acid value of kombucha.

**Table 2. Average results of Kombucha Total Dissolved Solids**

Pineapple Skin : Apple Tea	Average (%)
P 1 ( 0% : 100%)	0.3067 ± 0,015 <sup>b</sup>
P2 ( 2.5 % : 7.5 %)	0.2600 ± 0,010 <sup>a</sup>
P3 ( 50 % : 50 %)	0.3033 ± 0,015 <sup>b</sup>
P4 ( 7.5 % : 2.5 %)	0.3533 ± 0,020 <sup>c</sup>

The analysis of variance results in Table 2 show a significant difference ( $p < 0.05$ ) in the total acidity of kombucha due to variations in the ratio of pineapple peel to apple tea. The total acid value increased with increasing proportion of pineapple peel, with treatment P1 having the lowest total acid and P4 having the highest. This is due to the greater accumulation of organic acids during fermentation in treatments with a higher proportion of pineapple peel, as the sugars in pineapple peel are fermented by yeast into ethanol, which is then converted by acetic acid bacteria into organic acids, thereby increasing the acidity of the beverage (Villarreal-Soto et al., 2018; Phung Tu Ly et al., 2023).

## Total Dissolved Solids

Presenting the average results of total dissolved solids of kombucha made from pineapple skin (*Ananas comosus* L. Merr.) and apple tea (*Malus domestica*) with different treatment ratios, which have an effect on the total dissolved solids value of kombucha.

**Table 3. Average results of Kombucha Total Dissolved Solids**

Pineapple Skin : Apple Tea	Average (%)
P 1 ( 0% : 100%)	7.0333 ± 0.057 <sup>b</sup>
P2 ( 2.5 % : 7.5 %)	6.5667 ± 0.251 <sup>a</sup>
P3 ( 50 % : 50 %)	6.8667 ± 0.152 <sup>ab</sup>
P4 ( 7.5 % : 2.5 %)	7.0667 ± 0.152 <sup>b</sup>

Analysis of variance (ANOVA) results showed significant differences ( $p < 0.05$ ) in the total soluble solids of kombucha due to variations in the ratio of pineapple peel to apple tea. The highest total soluble solids value was obtained in treatment P4 at 7.0667, while treatment P2 had the lowest value at 6.5667, with treatments P1 and P3 falling in between. This difference indicates that the proportion of pineapple peel affects the content of soluble compounds in kombucha, because simple sugars and other compounds in pineapple peel partially remain after fermentation, although some are converted to ethanol and organic acids by microorganisms. This finding is in line with previous reports stating that the type of raw material and fermentation process affect total soluble solids, and the use of fruit-based ingredients tends to produce higher TPT values than tea-based kombucha (De Oliveira et al., 2020; Kitwetcharoen et al., 2023; Zubaidah et al., 2023).

## Phenolic Content

Presenting the average results of phenolic content of kombucha made from pineapple skin (*Ananas comosus* L. Merr.) and apple tea (*Malus domestica*) with different treatment comparisons, which have an effect on the phenolic content of kombucha.

**Table 4. Average results of Kombucha Phenolic Content**

Pineapple Skin : Apple Tea	Average (%)
P 1 ( 0% : 100%)	11.6000 ± 0.900 <sup>c</sup>
P2 ( 2.5 % : 7.5 %)	4.1433 ± 0.410 <sup>b</sup>
P3 ( 50 % : 50 %)	3.5400 ± 0.415 <sup>b</sup>
P4 ( 7.5 % : 2.5 %)	1.2233 ± 0.187 <sup>a</sup>

The results of the analysis of variance showed a significant difference ( $p < 0.05$ ) in the phenolic content of kombucha due to variations in the ratio of pineapple peel and apple tea. The highest phenolic value was found in treatment P1 at 11.6000, while treatment P4 had the lowest value at 1.2233, with treatments P2 and P3 being in between, at 4.1433 and 3.5400, respectively. This pattern indicates a decrease in phenolic content as the proportion of pineapple peel increases and apple tea decreases, because pineapple peel contains lower phenolics than apple tea. In addition, the degradation of phenolic compounds during fermentation and the enzymatic activity of microorganisms that hydrolyze complex compounds into simpler forms also affect the final levels and bioavailability of phenolics. Thus, the composition of the fermentation substrate plays an important role in determining the functional value of kombucha (Jakubczyk et al., 2020; De Oliveira et al., 2020; Zubaidah et al., 2023; Kitwetcharoen et al., 2023).

## 2. Organoleptic Test

Presenting the results of organoleptic tests of kombucha made from pineapple skin (*Ananas comosus* L. Merr.) and apple tea (*Malus domestica*) with each different treatment having an effect on the level of preference for kombucha.

**Table 5. Average results of the kombucha hedonic test**

Treatment	Parameter				
	Flavor	Color	Aroma	Average	Category
P1	3.37 ± 0.107a	3.69 ± 0.057b	3.65 ± 0.503a	3.57	Neutral
	3.73 ± 0.088a	3.95 ± 0.503a	3.86 ± 0.173a		
P2	3.45 ± 0.136a	3.37 ± 0.125a	3.34 ± 0.051a	3.39	Neutral
	3.32 ± 0.034a	3.32 ± 0.101a	3.55 ± 0.200a		
P3	3.32 ± 0.034a	3.32 ± 0.101a	3.55 ± 0.200a	3.39	Neutral
	3.32 ± 0.034a	3.32 ± 0.101a	3.55 ± 0.200a		
P4	3.32 ± 0.034a	3.32 ± 0.101a	3.55 ± 0.200a	3.39	Neutral
	3.32 ± 0.034a	3.32 ± 0.101a	3.55 ± 0.200a		

### Color

The organoleptic test results showed that the ratio of pineapple peel and apple tea affected the color of kombucha, with a significant value ( $p < 0.05$ ) based on the Kruskal–Wallis test. The most preferred color was obtained in treatment P2 (25% pineapple peel: 75% apple tea) with an average score of 3.95, included in the neutral category. The lowest color was found in P4 (75% pineapple peel: 25% apple tea) with a score of 3.32, also in the neutral category, although the difference between treatments was relatively small. This indicates that a higher proportion of apple tea tends to produce a more attractive kombucha color for panelists.

### Aroma

The ratio of ingredients also affected the aroma of kombucha, as indicated by a significant value ( $p < 0.05$ ). The most preferred aroma was found in treatment P2 with an average score of 3.86 (neutral), while the lowest aroma was found in P3 (50% pineapple peel: 50% apple tea) with a score of 3.34 (neutral). These results indicate that the addition of apple tea provided a more acceptable aroma to panelists than a higher proportion of pineapple peel.

### Flavor

The taste test results showed the effect of using pineapple peel and apple tea, but the Kruskal–Wallis value showed no significance ( $p > 0.05$ ). The most preferred flavor was found in P2 with a score of 3.73 (neutral), while

# THE EFFECT OF THE PROPORTION OF PINEAPPLE SKIN AND APPLE TEA ON THE CHEMICAL AND ORGANOLEPTIC CHARACTERISTICS OF KOMBUCHA

Sholikha Amalia Putri et al

the lowest taste was found in P4 with a score of 3.32 (neutral). Although the difference was not significant, this pattern still indicates that the proportion of 25% pineapple peel and 75% apple tea produced a flavor combination that was more acceptable to panelists.

### 3. Determination of Best Treatment (effectiveness test)

Effectiveness testing is used to determine the best and most preferred treatment.

**Table 8. Effectiveness Test Results**

Parameter	Mark Results (NH) Treatment			
	P 1	P 2	P 3	P 4
Level pH	0.00 0	0.0 38	0, 120	0.1 58
Total Acid	0.088	0, 158	0.0 88	0, 000
Total Dissolved Solids	0, 132	0.00 0	0.0 84	0, 140
Phenolic Content	0, 140	0.0 39	0.0 31	0, 000
Color	0.0 72	0.1 23	0.0 10	0.00 0
Aroma	0.0 73	0, 1 23	0.0 00	0.050
Flavor	0.0 19	0.1 58	0.0 50	0.00 0
<b>Total</b>	<b>0.524</b>	<b>0.6 39 *</b>	<b>0, 383</b>	<b>0, 348</b>

Based on the determination of effectiveness test on all research parameters, snack bar with treatment code P2 is the best treatment with a yield value (NH) of 0.639. The parameter criteria obtained include pH level of 3.57%, total acid 0.26%, total dissolved solids 6.56%, phenolic content 4.14%, color 3.95 (neutral category), aroma 3.86 (neutral category), and taste 3.73 (neutral category).

### CONCLUSION

Based on the research results, it can be concluded that the use of pineapple peel (*Ananas comosus* L. Merr.) and apple tea (*Malus domestica*) has a significant effect on pH, total acid, total soluble solids, phenolic content, and organoleptic attributes such as color, aroma, and taste of kombucha. Increasing the proportion of pineapple peel tends to decrease pH and phenolic content, while increasing total acid and total soluble solids. Conversely, a higher proportion of apple tea results in higher pH and phenolic content and lower total acid. The best treatment was obtained in kombucha with a ratio of 25% pineapple peel and 75% apple tea (P2), with a pH value of 3.57; total acid 0.26%; total soluble solids 6.5667; phenolic content 4.1433; color 3.95 (neutral category); aroma 3.86 (neutral category); and taste 3.73 (neutral category). These findings indicate that the combination of pineapple peel and apple tea in these proportions has the optimal potential to produce kombucha with balanced chemical and organoleptic characteristics.

### REFERENCES

- Anwar, C., Irhami, I., & Aprita, I. R. (2024). Production of kombucha drink by investigating the comparison of butterfly pea flower with pineapple juice and SCOBY starter concentration. *ResearchGate*. <https://www.researchgate.net/publication/392093483>
- Budiandari, R. U., Handayani, T., & Ramadhani, P. (2023). Studi karakteristik kimia minuman probiotik kombucha sari kulit nanas (*Ananas comosus*). *Jurnal Teknologi Pangan*, 14(2), 181–188. <https://doi.org/10.35891/tp.v14i2.3890>
- Cano-Lamadrid, M., & Artés-Hernández, F. (2022). Thermal and non-thermal treatments to preserve and encourage bioactive compounds in fruit- and vegetable-based products. *Foods*, 11(21), 3400. <https://doi.org/10.3390/foods11213400>
- De Oliveira, A. A., Lima, C. M. G., Pagnossa, J. P., da Silva, L. A., & others. (2020). Development, microbiological and physicochemical analysis of kombucha-based fermented beverage. *Research, Society and Development*, 9(11), e10021. <https://doi.org/10.33448/rsd-v9i11.10021>

- Halim, G. J., Hartati, F. K., & Yuniati, Y. (2025). Kombucha apel sebagai substitusi vinegar pada dressing vinaigrette. *Jurnal Sains dan Teknologi Pangan*, 3(1), 45–55. <https://jstpuho.id/index.php/jstp/article/view/57/56>
- Huey, T. S., Halim, M., Rahman, N. A., Sobri, Z. M., Yusof, M. T., Pak-Dek, M. S., Manaf, Y. N. A., & Was, H. (2025). Effect of pineapple peel on enzyme production and antioxidant potential in SCOBY fermentation. *Journal of Biochemistry, Microbiology and Biotechnology*, 13(1), 108–116. <https://journal.hibiscuspublisher.com/index.php/JOBIMB/article/view/1086>
- Jakubczyk, K., Kałduńska, J., Kochman, J., & Janda, K. (2020). Chemical profile and antioxidant activity of the kombucha beverage derived from white, green, black and red tea. *Antioxidants*, 9(5), 447. <https://doi.org/10.3390/antiox9050447>
- Jayabalan, R., Malbaša, R. V., Lončar, E. S., Vitas, J. S., & Sathishkumar, M. (2014). A review on kombucha tea—Microbiology, composition, fermentation, beneficial effects, toxicity, and tea fungus. *Comprehensive Reviews in Food Science and Food Safety*, 13(4), 538–550. <https://doi.org/10.1111/1541-4337.12073>
- Liao, T., Li, X., Fan, L., Xu, J., Chen, Y., & Zhang, Y. (2024). Nature of back slopping kombucha fermentation process: Insights from the microbial succession, metabolites composition changes and their correlations. *Frontiers in Microbiology*, 15, 1433127. <https://doi.org/10.3389/fmicb.2024.1433127>
- Muchlisun, A., Praptiningsih, Y., & Choiron, M. (2023). Karakteristik apel manalagi celup yang dibuat dengan variasi lama blanching dan suhu pengeringan. *Jurnal Teknologi Hasil Pertanian UNEJ*, 5(2), 123–132.
- Nyhan, L., Lynch, K. M., Sahin, A. W., & Arendt, E. K. (2022). Advances in kombucha tea fermentation: A review. *Applied Microbiology*, 2(1), 5–20. <https://doi.org/10.3390/applmicrobiol2010005>
- Ojo, A., & de Smidt, O. (2023). Microbial composition, bioactive compounds, potential benefits and risks associated with kombucha: A concise review. *Fermentation*, 9(5), 472. <https://doi.org/10.3390/fermentation9050472>
- Rosita, Handito, D., & Amaro, M. (2021). Pengaruh konsentrasi starter SCOBY (Symbiotic Culture of Bacteria and Yeast) terhadap mutu kimia, mikrobiologi dan organoleptik kombucha sari apel. *Pro Food*, 12–18. <https://profood.unram.ac.id/index.php/profood/article/download/226/122/1097>
- Siregar, R. N., Handarini, K., Suchahyo, B. S., & Hariyani, N. (2023). Pengaruh proporsi bunga telang (*Clitoria ternatea* L.) dan gula terhadap sifat kimia dan organoleptik minuman kombucha. *Pro-STek*, 5(2), 105–116. <https://doi.org/10.35194/prs.v5i2.3738>
- Tran, T., Billet, K., Torres-Cobos, B., Souchon, I., Bonnarme, P., Irlinger, F., & Landaud, S. (2022). Use of a minimal microbial consortium to determine the origin of kombucha flavor. *Frontiers in Microbiology*, 13, 836617. <https://doi.org/10.3389/fmicb.2022.836617>
- Villarreal-Soto, S. A., Beaufort, S., Bouajila, J., Souchard, J. P., & Taillandier, P. (2018). Understanding kombucha tea fermentation: A review. *Journal of Food Science*, 83(3), 580–588. <https://doi.org/10.1111/1750-3841.14068>
- Zubaidah, E., Rahmadani, R., Arifianti, L., & Srianta, I. (2018). Characteristic of physical, chemical, and microbiological kombucha from various varieties of apples. *IOP Conference Series: Earth and Environmental Science*, 131, 012040. <https://doi.org/10.1088/1755-1315/131/1/012040>