

Potential of Kalimantan White Pepper As a Raw Material for Kombucha Fermentation

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Abstract. Pepper can be expanded into processed products such as food and beverages. Kombucha is one of the products that can be made with pepper basic ingredients. Fermented kombucha tea has been shown to boost antioxidant activity. The presence of free phenolic substances obtained during the fermentation process causes an increase in antioxidant activity. The purpose of this study was to determine how pepper shape (powder and granule), concentration (5 and 10 g), and formulation (pepper alone and pepper coupled with black tea) affected the physicochemical properties of pepper-based kombucha. Kombucha was made by fermenting a 20% sucrose solution with a bacterial and yeast symbiotic culture (SCOBY) for 14 days. The parameters tested were pH, total sugar (°Brix), and total titratable acidity. The result of this study is the addition of 10 grams of pepper granules resulted in the lowest pH value (3.43), the lowest total sugar was in the treatment of tea pepper powder adding 10 grams (15.00) and the highest was a mixture of tea pepper powder 5 grams (17.87 Brix). The third analysis is total acid showed the lowest total acid value in the tea pepper granule treatment with the addition of 5 grams (70.74 %) and the highest, namely a mixture of tea pepper granules 10 grams (94.61 %). Based on overall physicochemical characteristics, the addition of 10 g pepper granules produced the best kombucha quality. These findings indicate that white pepper has strong potential as a raw material for kombucha fermentation

Keyword: Fermentation, Kombucha, Total Acid, Total Sugar, White Pepper

1 Introduction

Pepper is one of the most important commodities with high potential in East Kalimantan. The existing superior pepper variety is malonan 1, which is a native variety of East Kalimantan. East Kalimantan local pepper is a year-round bearing variety with a fresh fruit production potential of 2.94 kg/tree/year or the equivalent of 2.17 tons.ha⁻¹ white pepper. The spicy taste and distinct aroma of local East Kalimantan pepper are due to the high content of piperine and oleoresin, which is 11.23% oleoresin and 3.82% piperine [1]. Pepper is an export commodity in both black and white pepper whole grains. In addition to the development of diversification, the existing diversification of pepper products includes various products of green pepper, oleoresin, pepper oil, pepper perfume, and other products that use pepper as a flavor. Many people associate pepper with health products. The creation of pepper diversification products is a strategic step that must be taken to increase market absorption and the commodity's economic value.

So far, processed pepper products have only been processed as flavoring food additives. This is because pepper has a spicy taste and a strong aroma, so products made from the main raw pepper have not been developed. Piperine is the main component of the spicy flavor of pepper obtained at a concentration of 50-90 g piperine/kg pepper [2]. Pepper fruit contains antioxidant vitamins like vitamin C and vitamin A, as well as antioxidant flavonoid polyphenols like carotene, cryptoxanthin, zeaxanthin, and lycopene.

Because Indonesian pepper is still traded in traditional forms, namely black pepper and white pepper, which are exported in bulk, the added value of pepper commodities is very likely to increase. In the importing country, the pepper is sterilized, graded, milled, and packaged before being sold to the food, household, and restaurant industries. There are numerous diversified pepper products in global trade, including various green pepper products, oleoresins, pepper oil, and their derivatives. Pepper product diversification is very promising and has the potential to be developed because the technology is already available and can be applied from the rural level to small and medium-sized businesses.

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Kombucha is a traditional fermented beverage made by fermenting tea-dissolved sugar with a bacterial and yeast symbiotic culture (SCOBY). Kombucha is typically made from a tea solution, with few exceptions using herbs. Kombucha tea has a sour and refreshing flavor that is similar to apple cider. Microorganisms from the yeast and bacteria groups are used in the fermentation of kombucha. If acetic acid bacteria do not use sucrose directly, they work slowly, whereas yeast degrades sucrose into glucose and fructose, which is then fermented to produce ethanol. Organic acids, such as acetic, gluconic, glucuronic, and polyphenolic acids, dominate the chemical structure of kombucha. The health benefits of consuming kombucha tea include anti-carcinogenic, anti-diabetic, detoxifying potential, increased immune response, stomach ulcer treatment, and treatment of high blood cholesterol [3]. However, there are still very few research on pepper-based kombucha, especially with indigenous Indonesian white pepper varieties. Additionally, there hasn't been a comprehensive assessment of how pepper shape and concentration affect kombucha fermentation properties. In order to determine the optimal method for producing pepper-based kombucha, this study sought to examine the effects of pepper shape, concentration, and formulation on the physicochemical characteristics of kombucha.

2 Method

This study's materials included white pepper, Malonan 1 variety, starter kombucha (Scoby), sucrose, folin ciocalteau, methanol, PP solution, hand refractometer, pH meter, thermometer, Analytical Scales, Gas Stove, filter cloth, glass jars, and other analytical equipment are used. The experiment was conducted using a factorial design with three factors:

1. Formulation: pepper combined with black tea and pepper alone
2. Pepper form: powder and granule
3. Pepper concentration: 5 g and 10 g

Kombucha was prepared by dissolving 20% (w/v) sucrose in boiling water. Black tea and/or pepper were added according to the treatment and brewed for 5 minutes. The solution was filtered and allowed to cool to room temperature. After cooling, SCOBY and starter liquid were added, and the fermentation was carried out in sterilized glass jars at room temperature for 14 days under aerobic conditions.

The pH, total sugar (Brix), and total titrated acid are the three analytical parameters used in this study. Titration is used to calculate total acid. The kombucha sample was titrated with NaOH until a color change occurred [3]. Total sugar using hand refractometer and pH value using pH meter.

Data were analyzed using analysis of variance (ANOVA), followed by Tukey's test at a 5% significance level to determine differences among treatments.

3 Result and discussion

This research was carried out with three factors, namely mix (pepper tea and pepper), pepper shape (powder and granule), number of pepper (5 and 10 grams). Kombucha is made by combining 20% sucrose in boiling water and then adding tea and pepper according to the treatment for 5 minutes. After cooling, it is stored in a glass jar with a scoby starter and incubated for 14 days. There are the findings of the analysis :

Table 1. Result Analysis

Sample	pH	Total Sugar (Brix)	Total Acid (%)
Tea Pepper Granula 5 gram	3.87 _a	17.87 _a	70.76 _a
Tea Pepper Powder 5 gram	3.80 _a	18.20 _a	82.89 _a
Tea Pepper Granula 10 gram	3.67 _{ab}	15.20 _b	94.61 _b
Tea Pepper Powder 10 gram	3.63 _{ab}	15.00 _b	84.87 _{ab}
Pepper Granula 5 gram	3.43 _b	16.93 _a	90.64 _b
Pepper Powder 5 gram	3.48 _{ab}	17.07 _a	82.49 _{ab}
Pepper Granula 10 gram	3.43 _b	16.13 _{ab}	84.87 _{ab}
Pepper Powder 10 gram	3.44 _{ab}	17.40 _{ab}	90.04 _b

Note : The analysis results are an average of three repetitions, and the numbers followed by the same lowercase letters show no significant difference using Tukey's follow-up test at a significance level of 5%.



Fig. 1. Kombucha using Tea and Pepper Granula and Pepper Powder



Fig. 2. Kombucha using Pepper Granula and Pepper Powder

The findings of the analysis showed that the mixture of black tea and pepper produced significant results on the pH parameter, and the difference in the quantity of mixture addition produced significant results as well, while the difference in form produced no significant results. According to the table above, the addition of 10 grams of pepper granules resulted in the lowest pH value and the addition of 5 grams of pepper tea granula resulted in the highest.

The pH decreased along with the length of fermentation of the red galangal kombucha drink. The decrease in pH occurred due to the growth and metabolism of the kombucha starter, namely yeast, acetic acid bacteria, and lactic acid bacteria which increased organic acids. In aerobic conditions the kombucha starter was able to change tea sugar within 7 to 10 days so that the drink will become slightly acidic, producing 14 amino acids, vitamins and several hydrolytic enzymes. The pH value is one of the most important environmental parameters in influencing kombucha fermentation because several acids are formed such as acetic and gluconic. kombucha that is suitable for consumption is in the pH range of 2.5-4.6 [4].

The decrease in kombucha pH was thought to be caused by an increase in acetic acid concentration during the fermentation process. Acetic acid dissolves and releases protons, causing the pH to fall. In addition to acetic acid, the kombucha fermentation process produces other organic acids that can cause a pH decrease. The decrease in pH during fermentation will help *Acetobacter xylinum* bacteria in kombucha culture survive and carry out their metabolic activities. The solubilized acetic acid will dissociate and release free protons, lowering the pH of the solution [5]

The analysis results showed that the total sugar parameter showed that the mixture of black tea and pepper and the difference in shape did not show significant results, but the difference in the amount of mixture addition based on the table above, the lowest total sugar value was in the treatment of tea pepper powder adding 10 grams and the highest was a mixture of tea pepper powder 5 grams.

The sucrose in kombucha serves as a source of energy for bacteria to survive through fermentation and respiration processes, rather than as a sweetener. The longer the fermentation, the lower the total sugar because sugar is used as a substrate by the kombucha culture to produce alcohol, organic acids, and other metabolites at the end of the fermentation. The decrease in sugar during fermentation was caused not only by yeast activity in the conversion of sugar to alcohol but also by Acetobacter activity in the conversion of glucose to gluconic acid. Furthermore, Acetobacter xylinum synthesizes cellulose [3].

The results of the analysis showed that the total acid parameter showed that the mixture of black tea and pepper and the difference in shape did not show significant results, but the difference in the amount of addition of the mixture based on the table above the lowest total acid value in the tea pepper granule treatment with the addition of 5 grams and the highest, namely a mixture of tea, pepper granules 10 grams.

The greater the total acid, the longer the fermentation. This is because, during the fermentation process, yeasts and bacteria metabolize sucrose and produce several organic acids such as acetic acid, gluconic acid, and glucuronic acid, thereby increasing organic acid levels. As a result, the higher the organic acid content of kombucha, the higher the total acid content. This is because the more acetic acid formed as a result of Acetobacter xylinum metabolism, the longer the fermentation time. The more acidic the fermentation, the longer it takes [3]

4 Conclusion

Diversification of processed pepper as a fermented beverage is an attempt to take advantage of the potential of pepper, particularly in East Kalimantan. Pepper is made into a kombucha product in which pepper is mixed with black tea and pure kombucha from pepper water produces the same result, indicating that pepper can be made into a fermented beverage. According to the findings of this study, the amount of tea and pepper added affects the pH value, total sugar, and acidity of the kombucha produced. The result of this study is the addition of 10 grams of pepper granules resulted in the lowest pH value (3.43), the lowest total sugar was in the treatment of tea pepper powder adding 10 grams (15.00) and the highest was a mixture of tea pepper powder 5 grams (17.87 Brix). The third analysis is total acid showed the lowest total acid value in the tea pepper granule treatment with the addition of 5 grams (70.74 %) and the highest, namely a mixture of tea, pepper granules 10 grams (94.61 %). The addition of 10 g pepper granules produced the best kombucha quality. This study demonstrates that local East Kalimantan white pepper can be effectively developed into a novel kombucha beverage with promising functional and economic potential.

ACKNOWLEDGMENTS

Thanks to funder and this research was funded Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) of Institut Teknologi Kalimantan.

References

1. Oti, Rostiana. 2018. Karakteristik Produksi Dan Mutu Lada Lokal Kalimantan Timur. Buletin Penelitian Tanaman Rempah dan Obat, Vol. 28 No. 2, 2017 : 113 – 126. DOI : <http://dx.doi.org/10.21082/bullitro.v28n2.2017.113-126>
2. Risfaheri. 2013. Pengkajian Teknologi Pengolahan Lada Putih Skala Usaha Kecil Sesuai Persyaratan Keamanan Pangan. Pangkalpinang: Balai Pengkajian Teknologi Pertanian.
3. C. N. Primiani, Pujiati, M. Mumtahanah, and W. Ardhi, "Kombucha fermentation test used for various types of herbal teas," *J. Phys. Conf. Ser.*, vol. 1025, no. 1, 2018, doi: [10.1088/1742-6596/1025/1/012073](https://doi.org/10.1088/1742-6596/1025/1/012073)
4. Julijana Tomovska, Nikola Gjorgievski, and Borche Makarijoski, "Examination of pH, Titratable Acidity and Antioxidant Activity in Fermented Milk," *J. Mater. Sci. Eng. A*, vol. 6, no. 6, pp. 326–333, 2016, doi: [10.17265/2161-6213/2016.11-12.006](https://doi.org/10.17265/2161-6213/2016.11-12.006)
5. L. M. Nyhan, K. M. Lynch, A. W. Sahin, and E. K. Arendt, "Advances in Kombucha Tea Fermentation: A Review," *Appl. Microbiol.*, vol. 2, no. 1, pp. 73–101, 2022, doi: [10.3390/applmicrobiol2010005](https://doi.org/10.3390/applmicrobiol2010005).