Research Article

Development of Pineapple Peel Vinegar

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Abstract: *Pineapple peel is part of the by-products from pineapple processing industries and harvesting activities. The pineapple waste produced from rising demands of pineapple products worldwide will eventually disturb the environmental balance and contribute to environmental pollution. Further utilization of pineapple waste into valuable products can reduce the waste generated, conserve the environment, and potentially generate income from the developed products. In this study, peel from four types of Malaysian pineapple namely Morris, Josephine, MD2 and N36 were used to produce vinegar. Vinegar has been reported to offer beneficial health effects when taken regularly. This study's objective is to determine the vinegar characteristics produced from each pineapple peel by evaluating the physicochemical analysis and antioxidant activity. The vinegar was prepared by adding pineapple peels with sugar, distilled water, viable yeast, and yeast nutrient to a beaker. Sodium bicarbonate was added to adjust the pH to 4.0. The beaker was sealed, and the fermentation was allowed to take place at 25 - 28°C for two days. The fermenter was then filtered, the filtrate was covered and further fermented for another 11 days. Results obtained indicate that the suitable pineapple peel for production of vinegar was the peel of MD2. MD2 peel vinegar showed the lowest pH, browning values and total acidity compared to others. Meanwhile for antioxidant activities using DPPH method, MD2 pineapple peel showed the highest antioxidant activity among the other types of pineapple peel.*

Keywords: pineapple peel vinegar; physicochemical characteristic; antioxidant activity

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1. INTRODUCTION

Pineapple (*Ananas comosus*) is a tropical fruit widely consumed worldwide for its sweet and tangy flavor. The pineapple processing industry generates a significant amount of waste, primarily in the form of peels, which are often discarded as agricultural waste. However, pineapple peels are rich in sugars, fibers, and other nutrients, making them a valuable resource for the production of vinegar.

Pineapple peel vinegar is a product derived from the fermentation of pineapple peels and have numerous potential applications. The vinegar is not only a flavorful culinary ingredient but also possesses several health benefits, including antimicrobial and antioxidant properties. Additionally, the production of pineapple peel vinegar also offers an environmentally friendly solution for utilizing pineapple waste, contributing to the reduction of agricultural waste and promoting sustainable practices. In this project, four types of pineapple peel have been used which are MD2, Morris, N36 and Josephine pineapple. The antibacteria and anti-infection abilities of vinegars are mainly due to the presence of organic acids, polyphenols, and melanoidins. The polyphenols and melanoidins also provide the antioxidant abilities of vinegars, which are produced from the raw materials and fermentation processes, respectively (Chen et al., 2016).

This research is to explore the development of pineapple peel vinegar, highlighting its importance as a sustainable approach to waste utilization.

2. METHOD & MATERIAL

Four types of Malaysian pineapple peels namely Morris, Josephine, MD2 and N36 were obtained. The pineapple peel was washed to remove any foreign matter. 179 g peel was weighed, chopped into pieces, and then put into Buckner conical flask (1000ml). 20 g of sugar and 800 ml of distilled water were added into the beaker followed by 3.0 g viable yeast and 6.0 g of yeast nutrient (ammonium phosphate). Sodium bicarbonate was added to adjust the pH to 4.0. The beaker was sealed for two days for fermentation process at 25˚C to 28˚C. After two days, baker yeast first shaped the alcohol and then the residue was filtered. The filtrate was then covered to allow Acetobacter to come in by a chanced approach process. Acetobacter converted the ethanol into acetic acid in 11 days (Yusuf O. Raji, 2012).

The physicochemical properties of the vinegar produced such as pH, browning values, total sugar content and total acidity were evaluated. pH meter was used to measure the pH of vinegar. The browning colour was measured in 200-fold diluted samples at 290 nm using spectrophotometer. The total sugar content was evaluated using the refractometer and the reading was expressed as Brix degree. For total acidity in samples, acetic acid content was calculated. DPPH (2,2-diphenyl-1-picryl-hydrazyl-hydrate) free radical method was conducted to investigate the antioxidant activity of the vinegar. Spectrophotometer was used to measure absorbance at 517 nm.

3. FINDINGS

Color changes of vinegar developed before and after fermentation process were observed by comparing Figure 1 and Figure 2.

Figure 1. Vinegar before fermentation.

Figure 2. Vinegar after fermentation.

3.1 Physicochemical properties

Table 1 shows the summarized value of pH, Total Sugar Content, Total Acidity and Browning Value for each type of pineapple vinegar.

Table 1. Measured parameter to determine quality of pineapple peel vinegar.

	Josephine	**Morris**	**N36**	**MD2**
pH	4.10	4.16	4.01	3.8
Total Sugar Content	5.20 %	5.1 %	5 %	5.1 %
Total Acidity	4.144 %	4.127 %	4.144 %	4.110 %
Browning Value	0.097 %	0.285 %	0.119 %	0.097 %

3.2.2 Antioxidant activity

IC_{50} (Half maximal Inhibitory Concentration) value is the concentration of the sample that can scavenge 50% of DPPH free radical in DPPH free radical scavenging method. The IC_{50} values were obtained from prepared inhibition curves. The IC_{50} value is inversely proportional to the antioxidant property of the sample. Table 2 shows the IC50 value for each type of pineapple peel vinegar.

Table 2. IC_{50} value of pineapple peel vinegar

Type of pineapple peel	**IC_{50} (ppm)**
Josephine	824.63
Morris	1137.37
N36	569.26
MD2	113.63

4. DISCUSSION

The pH value of vinegar samples ranged from 3.8 to 4.16. This value is comparable with the pH of the pineapple peel vinegar reported by Chalchisa and Dereje (2021) ranged from 3.5 to 4.31. However, the pH is higher compared to vinegar pH obtained by Yusof (2012) which is 2.8. The low pH of vinegar can inhibit unwanted microbial growth and thus, enhancing the quality of the finished product. As the acetic concentration increases during the fermentation process, the pH value of vinegar decreases, and the bacteria presence decreases, which allows the colour of vinegar to change during the fermentation process. The color change also showed the optimized vinegar has been producing. A pH tended to decrease in most samples for each type of pineapple peel during the storage period or fermentation, mainly due to the amount of organic or total acids present in the vinegar (Liu et al., 2008). MD2 has the lowest pH value among the other pineapple peel meanwhile Morris has the highest pH value. This is due to the fact that the acidity and active yeast content of vinegar depend on several factors including maturity of fruits, total acid content, and total sugar content.

The total sugar content for each of the pineapple peel vinegar was measured and observed. All vinegars show decreasing total sugar content after 11 days of fermentation. High sugar content may lead to high ethanol and subsequently high acid content in the produce of vinegar (Selvanathan, 2020). The sugar content of pineapple peel vinegar that has decreased shows a sign of the growth of acetic bacteria in the fermentation. The total sugar content for the pineapple peels ranging from 5 to 5.2% with highest total sugar content is Josephine peel vinegar. From this, it was shown that the vinegar from Josephine peel has sweeter taste among others. The lowest percentage of total sugar content is vinegar

from N36 pineapple peel. Vinegar from N36 has lower sugar content is due to the production of higher acetic acid because it was used for growth and the reproduction of acetate bacteria (Kong et. al, 2017).

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According to Malaysian Food Act and Regulation, acetic acid content must be at least 4% for specific vinegar product (Jamaluddin et al., 2017). The total acidity for the vinegars ranging from 4.11 to 4.14% with the lowest total acidity is MD2. Total acid content are usually influenced by either fermentation or concentrates of the vinegar, and these may be responsible for the differences in total acid contents among vinegars (Kang et. al, 2020).

The browning color causes influenced by various factors, including the color of raw materials, chemical reactions during preparation, pigment produced by chemical or enzymatic reactions during fermentation, and the addition of caramel colorants (Liu et al., 2008). Based on result, the browning value for Jospehine and MD2 peel vinegar indicate possibility the lowest of food deterioration. Excessively high browning values, indicating a very dark color also may suggest over-fermentation or the presence of undesirable compounds. These vinegars may have a harsh or bitter taste, which is generally not desirable.

Lastly, IC50 value for MD2 indicate the highest antioxidant activity among all of the pineapple peel vinegar. The lower the IC50 value, the higher the antioxidant activity of samples (Jadid, 2017).

5. CONCLUSION

In conclusion, the objectives of this study have been successfully achieved. MD2 peel is suitable for vinegar production compared to other three pineapple peels because it fulfilled the physicochemical characteristics and showed the highest antioxidant activity for vinegar.

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References

Chalchisa T, Dereje B. (2021) From waste to food: Utilization of pineapple peels for vinegar production. *MOJ Food Process Technols*, 9(1), 1–5. DOI: 10.15406/mojfpt.2021.09.00254

Chen, H., Chen, T., Giudici, P., & Chen, F. (2016). Vinegar Functions on Health: Constituents, Sources, and Formation Mechanisms. Comprehensive reviews in food science and food safety, 15(6), 1124–1138. https://doi.org/10.1111/1541-4337.12228

Kong, C. T., Ho, C. W., Ling, A. J. W., Azwan Lazim, Shazrul Fazry, & Lim, S. J. (2018) Chemical changes and optimisation of acetous fermentation time and mother of vinegar concentration in the production of vinegar-like fermented papaya beverage. *Sains Malaysiana*, 47 (9). 2017-2026.

Liu, F., He, Y., & Wang, L. (2008). Comparison of calibrations for the determination of soluble solids content and pH of rice vinegars using visible and short-wave near infrared spectroscopy. *Analytica Chimica Acta*, 610(2), 196-204. http://dx.doi.org/10.1016/j.aca.2008.01.039. PMid:18291129.

Jamaludin, M.A., Amin, A., Fadzlillah, N. A., Kartika, B., Othman, R.,1Sani S. and Ramli A. (2017). study on physicochemical properties and the halalness of commercially marketed vinegar in Malaysia. *International Food Research Journal*, 24(Suppl), S428-S435

Jadid, N. (2017). Antioxidant activity of different solvent extracts of piper retrofractum Vahl.using DPPH assay. Surabaya, Indonesia: Department of Biology, Institut Teknologi Sepuluh Nopember.

Kang M., Ha, J. H. & Lee Y. S. (2022) Physicochemical properties, antioxidant activities and sensory characteristics of commercial grape vinegars during long-term storage. *Food and science technology*, https://doi.org/10.1590/fst.25119

Selvanathan, Y. (2020). Physicochemical properties, antioxidant activities and sensory evaluation of pineapple peel biovinegar. *Material Science and Engineering*, 991.

Yusuf O. Raji. (2012). Production of vinegar from pineapple peel. *International Journal of Advanced Scientific Research and Technology*, 3(2), 656 – 666