

Analysis of Alcohol Content in Fruit Vinegars as a Halal Testing Method for Fermented Products

Hanik Faizah, Mufidur Rohman, Estri Kusumawati, Nirmala Fitria Firdhausi*

Department of Biology, Faculty of Science and Technology, Universitas Islam Negeri Sunan Ampel, Surabaya, Indonesia

*nirmala.firdausi@uinsa.ac.id

Keywords: Persimmon Vinegar, Soursop Vinegar, Combined Vinegar, Alcohol Content, Halal Food Products.

Abstract: The significance of halal certification has experienced notable growth over time as a result of the escalating demand for halal food products. One of the critical points of halal certification for food and beverages is the alcohol content contained within them. Fermented products represent a category of food and beverages with a pivotal consideration in ensuring compliance with halal dietary restrictions, particularly in relation to alcohol content. This study aimed to determine the alcohol content in persimmon vinegar, soursop vinegar, and combined (mix of persimmon and soursop) vinegar. The study conducted experimental analyses to assess the alcohol concentration in fruit vinegars employing a specific gravity calculation method using a pycnometer. The study found that the combined fruit vinegar had the highest alcohol content at 0.195%, while persimmon vinegar had the lowest alcohol content at 0.15%. The results showed that persimmon vinegar, soursop fruit vinegar, and combined fruit vinegar contained alcohol content below 0.5%, aligning with the halal standards outlined in the MUI Fatwa No. 10 of 2018.

1 INTRODUCTION

Indonesia is widely acknowledged for its significant Muslim population, which places it within the category of a developing nation (Sultan, 2023). Islamic principles stipulate that follower must choose halal and thayyib (wholesome) products while avoiding those identified as haram, thereby promoting both physical and spiritual well-being. Halal products encompass a diverse array of items, including attire, beauty products, food such as beverages, and pharmaceuticals. Aligned with Islamic economic principles, the discourse surrounding halal has gained widespread global recognition as an economic phenomenon. Remarkably, Indonesia is among the top 10 countries worldwide in terms of consumption of halal goods, according to the 2017 Global Islamic Economy Indicator. The nation has been lauded as the largest global consumer of halal food and ranks sixth globally for halal cosmetics and pharmaceuticals. Notwithstanding these accomplishments, the Ministry of Religion of the Republic of Indonesia aims to establish itself as a leading global producer of halal goods across all sectors. The realization of this

ambition necessitates seamless coordination and collaboration among all stakeholders involved (Ministry of Religion of the Republic of Indonesia, 2017).

The significance of halal certification has notably escalated due to the surging demand for halal food products. Halal certification has the pivotal role in fostering consumer trust and expanding the halal market. In Indonesia, halal certificates are issued through three designated institutions as stipulated in Law No. 33 of 2014. These institutions include The Halal Product Assurance Organizing Body (BPJPH), The Halal Inspection Agency (LPH), and the Indonesian Ulema Council (MUI). The BPJPH is responsible for policy formulation, application verification, certification issuance, and labelling of halal products. Conversely, the LPH is tasked with assessing and verifying the halal status of products, employing halal auditors for inspection purposes. The MUI serves as a third-party entity in the halal certification process, conducting halal fatwa proceedings to ascertain product compliance with

halal standards (Ministry of Religion of the Republic of Indonesia, 2022).

One of the critical points of halal certification for food and beverages is the alcohol content contained within them. According to Islamic law, the consumption of alcoholic beverages is strictly prohibited, and the inclusion of such drinks in food or other beverages renders them haram (forbidden). However, this prohibition does not extend to naturally produced ethanol in low quantities. Ethanol levels can be tolerated in food and beverages if they do not pose adverse effects on the human body. The halal status of food products containing ethanol is determined by the concept of *Al Istihlak* (assimilation). This concept indicates the permissible level of ethanol in food products if the substance is dissolved in another halal substance that is in greater quantity than the ethanol (Najiha et al., 2010). According to MUI Fatwa No. 10 of 2018 concerning Food and Beverage Products Containing Alcohol/Ethanol, the tolerance level for ethanol in beverages is set at 0.5%, and is not harmful to the body (MUI, 2018). Fermented products are the primary category of food and beverage items commonly associated with the presence of ethanol. (Destanoğlu & Ates, 2019). Among these fermented foodstuffs, fruit vinegar stands as a widely recognized product.

Fruit vinegar is a fruit-derived alimentary product that undergoes a dual process of fermentation, which includes alcoholic fermentation and acetic acid fermentation. During the initial stage of fermentation, yeast converts the sugar content present in the fruit into ethanol and carbon dioxide (Antoniewicz et al., 2021). The presence of ethanol, a byproduct of this fermentation process, is a critical component of fruit vinegar. Therefore, evaluating the ethanol content of fruit vinegar is essential in determining its halal status. Previous studies have investigated the alcohol content in various fermented products. For example, Ester et al. (2021) reported an alcohol content of 0.99% in mas banana fruit vinegar, while Agustina et al. (2023) found that starfruit leaf kombucha tea contained 0.43% alcohol. These findings underscore the significance of investigating assessing the ethanol content in persimmon, soursop, and combination fruit vinegars, which are less commonly produced, to ascertain their halal compliance.

2 METHODS

Research Methods

This research used an experimental method. The production of fruit vinegar uses persimmon, soursop as the basic ingredients and a combination of persimmon and soursop is also produced. The three fruit vinegars were tested for alcohol content.

Materials and Tools

The materials used in this study are persimmon fruit, soursop fruit, sugar, mineral water, distilled water, tissue, filter paper, and NaOH.

The tools used in this study are glass bottles, stirring spoons, measuring glass, beaker glass, volumetric flask, micropipettes, micropipette tips, digital scales, analytical balance, and pycnometers.

Procedure

Fruit Vinegar Production

For the vinegar production, fresh fruits are selected, thoroughly washed, and dried. For soursop, the peel and seeds are extracted from the pulp. As for persimmon, the fruit is cut, and its seeds and stems are removed. Subsequently, 120 grams of each fruit is pulverized using a blender. The blended fruit is then placed into a 500 ml glass bottle, and 42 grams of sugar and 400 ml of sterile water are added. The mixture is stirred and covered with cloth. The fermentation process is carried out at room temperature between 21-26 °C for 41 days without the addition of yeast and bacteria cultures. After 41 days, the vinegar is filtered and then transferred into sterile bottles.

The Analysis of Alcohol Content

The evaluation of alcohol content in soursop and persimmon fruit vinegars in this study adopted the methodology delineated by Skoog (1985). A 25 ml sample from each vinegar type was extracted, neutralized with 3 N sodium hydroxide, and processed through distillation to yield 25 ml of distillate. The distilled product was transferred to a pycnometer affixed with a 25 ml thermometer. The pycnometer, initially weighed, was then immersed in cold water until attaining 28°C. Following this, the exterior of the pycnometer was desiccated using absorbent paper and re-weighed to determine the

specific gravity of the alcohol. The alcohol content in the fruit vinegar sample was deduced by comparing the specific gravity obtained with the reference specific gravity values. The specific gravity was computed using the ensuing formula:

$$\frac{(Pw + \text{distillate}) - Pw_{\text{empty}}}{(Pw + \text{distilled water}) - Pw_{\text{empty}}}$$

Where:

Pw : picnometer weight

Data Analysis

The data obtained from this study were the alcohol content of persimmon fruit vinegar, soursop fruit vinegar and their combination. The data were analyzed descriptively and compared with MUI Fatwa Number 10 of 2018.

3 RESULTS

The alcohol content of the vinegar

To identify strategies for developing halal food products in Indonesia using SWOT analysis. The approach taken is a desk study approach where secondary data is obtained from various journal articles, statistical report data, reports from government agencies related to food, electronic news and other secondary data.

The results of alcohol content of the various fruit vinegar in our study can be seen in Table 1. Our study found that each type of fruit vinegar exhibits distinct levels of alcohol content, with persimmon vinegar containing 0.15% alcohol, soursop vinegar containing 0.165% alcohol, and the combined (mix of persimmon and soursop) vinegar containing 0.195% alcohol. The highest alcohol content was observed in the combined vinegar (0.195%), while the lowest was found in persimmon vinegar (0.15%). Based on table 1, the alcohol content of all the fruit vinegar in our study was below 0.5%.

Table 1: The Alcohol Content of The Vinegar

Fruit Vinegar Types	Alcohol Content (%)
persimmon vinegars	0,15
Soursop vinegars	0,165
Combined vinegar (mix of persimmon and Soursop)	0,195

4 DISCUSSIONS

In this study, fruit vinegar was prepared utilizing persimmon and soursop as primary constituents. The fruits underwent an initial washing process to eliminate surface contaminants and mitigate any potential production inconsistencies. Subsequently, the fruit was diced and deposited into a sterile container with sugar solution. The introduction of liquid sugar serves to enhance the availability of carbon for the yeast, thereby optimizing the fermentation process (Jayus et al., 2019). The ensuing incubation period spanned 41 days, fostering the development of the fermented product in the form of fruit vinegar. Regular stirring during incubation played a pivotal role in ensuring the uniform distribution of nutrients and sugars. Upon completion of the incubation phase, the fruit vinegar underwent filtration to isolate residual fibers, which were then subject to assessment for ethanol levels.

The ethanol content in fruit vinegar cannot be separated from the role of microorganisms that carry out fermentation to produce new products as a result of this process. Among these microorganisms, *Saccharomyces cerevisiae* stands out as a prominent player in ethanol production. Notably, ethanol is derived from the conversion of glucose facilitated by *S. cerevisiae*. This transformative process relies on the enzymatic activity regulated by *S. cerevisiae*. Research indicates that approximately twelve enzymes are required for the conversion of glucose into CO₂ and ethanol. Of these enzymes, ten are involved in the conversion of glucose to pyruvate, generating ATP to fuel yeast proliferation, while the remaining two enzymes oversee the conversion of pyruvate into final fermentation byproducts to ensure redox equilibrium is maintained within the yeast. Therefore, the availability of metal ions in the fermentation medium can significantly impact the overall progression of fermentation and the efficacy of sugar-to-ethanol conversion. The reactions that occur during the glucose conversion process take place under anaerobic conditions. Pyruvic acid, which is the product of sugar catabolism, serves as an acceptor of NADH, a reduced coenzyme, in *S. cerevisiae*. Subsequently, acetaldehyde is utilized to transform pyruvic acid into ethanol, with alcohol dehydrogenase facilitating the final step by regenerating NAD⁺ to sustain glycolysis and ATP synthesis. The significant role of the final step reaction in ethanol production forms the cornerstone of the predominant fermentation industry (Walker & Walker, 2018).

Ethanol, an organic alcohol compound, features a hydroxyl functional group where the terminal end binds to a saturated carbon atom (CH₃CH₂OH). The presence of these compounds in food varies based on the storage process and specific type of food product (Alsaleem et al., 2022). According to Luzón-Quintana et al. (2021), alcohol contents in fruit vinegar are influenced by sugar additions during manufacturing or inherent sugar content in base ingredients, given the direct linkage between sugar and alcoholic fermentation processes. Ethanol, resulting from alcoholic fermentation, undergoes conversion back into acetic acid through the action of acetic acid bacteria in aerobic conditions (Vidra & Németh, 2018). Nonetheless, only approximately 95% of ethanol undergoes conversion to acetic acid by these bacteria (Aryanti, 2015). The alcohol content within the final fruit vinegar product depends on the abundance of *Acetobacter aceti* bacteria. An increased concentration of *Acetobacter aceti* inoculum leads to reduced alcohol content in fruit vinegar, whereas a lower inoculum concentration results in higher alcohol content in fruit vinegar. This is due to the pivotal role of *Acetobacter aceti* in the conversion of ethanol to acetic acid (Idayanti & Rosida, 2022).

The analysis of alcohol content in this study was conducted using the method of specific gravity calculation employing a pycnometer. A distilled vinegar sample was subjected to a one-hour distillation process to extract pure alcohol, isolating it from water and other components before specific gravity measurement. Subsequently, the weights of the obtained pure alcohol from distillation and distilled water, used for comparison, were measured utilizing a pycnometer. Through this procedure, the alcohol content of the vinegar sample was then derived by comparing its weight to that of distilled water which has been measured. The results of alcohol content analysis on various vinegar samples were summarized in Table 1.

Our study found that each type of fruit vinegar exhibits distinct levels of alcohol content, with persimmon vinegar containing 0.15% alcohol, soursop vinegar containing 0.165% alcohol, and the combined vinegar containing 0.195% alcohol. The highest alcohol content was observed in the combined vinegar, while the lowest was found in persimmon vinegar. These findings affirm that the fruit vinegar generated in this study is permissible for consumption, as it complies with the alcohol content threshold for food products stipulated by the Indonesian Council of Ulama (MUI) Fatwa No. 10 of

2018 regarding Food and Beverage Products Containing Alcohol/Ethanol, which stated that such products should not exceed 0.5% alcohol/ethanol. The findings of our study align with a study conducted by Nurismanto et al. (2014). In the study, the production of banana fruit vinegar with variations in fermentation time was carried out and tested for alcohol content. From the test, the alcohol content contained in banana fruit vinegar with a fermentation time of 10 days was 0.38%. In contrast, Idayanti and Rosida (2022) reported that the alcohol content in grape vinegar, kersen fruit vinegar, and starfruit vinegar in their study did not meet the MUI Standard No. 10 of 2018. Alcohol content of kersen fruit vinegar, starfruit and grape produced ranged from 1.83-2.43%.

Furthermore, the fruit vinegar in our study meets the quality criteria outlined in MUI Fatwa No. 10 of 2018, as alcohol generated through a spontaneous or traditional fermentation method devoid of any prohibited additives. This will be different case if the production process of vinegar subjected to non-spontaneous fermentation methods, which requires yeast or bacterial inoculum. Apart from alcohol levels, there are several critical halal points that need to be observed. The critical points include the source of the microbes and the source of the fermentation media (MUI, 2018). Several critical points must be considered when assessing the permissibility of fermented products within the context of Islamic dietary laws. Among these factors, the origin and alcohol content of the product stand out as vital elements that require careful examination.

5 CONCLUSIONS

Based on the alcohol content analysis, we found that the combined fruit vinegar exhibited the highest alcohol content (0.195%). Conversely, the lowest alcohol content was found in persimmon vinegar (0.15%). Our study revealed that persimmon, soursop and combined vinegar had an alcohol content below 0.5% which is in accordance with the halal standards of MUI Fatwa No. 10 of 2018.

6 REFERENCES

- Agustina, E., Rosyada, F. F. A., & Faizah, H. (2023). Effect Fermentation Time of Halal Label Wuluh Starfruit Leaves Kombucha Tea (*Avverhoa bilimbi* Linn.) Based on Alcohol

- Content and Chemical Characteristic. Proceedings of International Conference on Halal Food and Health Nutrition, 1(1), 73–78. <https://doi.org/10.29080/ichafohn.v1i1.1128>
- Alsaleem, T., Alsaleem, T., Al-dhelaan, R., Allaheeb, G., Alkhidhr, M., Bintahhah, A., & Alowaifeer, A. (2022). Evaluation of Ethanol Formation in Fruit Juices During Refrigerated Storage Time and Its Halal Status. *International Journal of Halal Research*, 4(1), 19–28.
- Antoniiewicz, J., Jakubczyk, K., Kwiatkowski, P., Maciejewska-markiewicz, D., Kochman, J., Rębacz-Marón, E., & Janda-Milczarek, K. (2021). Analysis of antioxidant capacity and antimicrobial properties of selected polish grape vinegars obtained by spontaneous fermentation. *Molecules*, 26(16). <https://doi.org/10.3390/molecules26164727>
- Aryanti, C. W. (2015). Pengaruh Lama Fermentasi Dan Varietas Buah Naga (*Hylocereus* spp.) Terhadap Aktivitas Antibakteri Cuka Buah Naga. Skripsi. Fakultas Teknologi Pertanian, Universitas Brawijaya.
- Destanoğlu, O., & Ates, I. (2019). Determination and Evaluation of Methanol, Ethanol and Higher Alcohols in Legally and Illegally Produced Alcoholic Beverages. *Journal of The Turkish Chemical Society: Chemistry*, 6(1), 21–28.
- Ester, S. R., Mukarlina, & Rahmawati. (2021). Aktivitas Bakteri Asam Asetat Dalam Proses Pembuatan Cuka Daging Pisang Mas (*Musa acuminata*, L.). *Probiotic*, 10(1), 22–25.
- Idayanti, F., & Rosida, D. F. (2022). Karakteristik Fisikokimia Cuka Buah Kersen, Belimbing Dan Anggur Dengan Penambahan Konsentrasi Inokulum *Acetobacter acetii*. *AGRITEPA: Jurnal Ilmu Dan Teknologi Pertanian*, 9(2), 365–384.
- Jayus, J., Rosyidawati, E. H., & Purnomo, B. H. (2019). Akselerasi Produksi Moromi Menggunakan Inokulum *Pediococcus halophilus* FNCC 0033 Dan *Zygosaccharomyces rouxii* FNCC 3008. *Jurnal Agroteknologi*, 13(02).
- Luzón-Quintana, L. M., Castro, R., & Duran, E. (2021). Biotechnological Processes in Fruit Vinegar Production. *Foods*, 10, 945.
- Kementerian Agama Republik Indonesia. (2017). Negara dan Sertifikasi Halal Indonesia. Diakses pada <https://kemenag.go.id/opini/negara-dan-sertifikasi-halal-indonesia-cfxy63>
- Kementerian Agama Republik Indonesia. (2022). Bagaimana Sinergi BPJPH, LPH, dan MUI dalam Sertifikasi Halal? Ini Penjelasan Kemenag. Diakses pada <https://www.kemenag.go.id/pers-rilis/bagaimana-sinergi-bpjph-lph-dan-mui-dalam-sertifikasi-halal-ini-penjelasan-kemenag-t5j3dq>
- Majelis Ulama Indonesia (MUI). 2018. Fatwa MUI No. 10 Tahun 2018 Tentang Produk Makanan Dan Minuman Yang Mengandung Alkohol/Etanol
- Kementerian Agama Republik Indonesia. (2017). Negara dan Sertifikasi Halal Indonesia. Diakses pada <https://kemenag.go.id/opini/negara-dan-sertifikasi-halal-indonesia-cfxy63>
- Najiha, A. A., Tajul, A. Y., Norziah, M. H., & Nadiyah, W. A. W. (2010). A Preliminary Study on Halal Limits for Ethanol Content in Food Products. *Middle-East Journal of Scientific Research*, 6(1), 45–50.
- Nurismanto, R., Mulyani, T., & Ning, I. (2014). Pembuatan Asam Cuka Pisang Kepok (*Musaparadisiaca* L.) Dengan Kajian Lama Fermentasi Dan Konsentrasi Inokulum (*Acetobacter acetii*). *Jurnal Teknologi Pangan*, 8(2), 149–155.
- Sultan, B. (2023). the Contributions of Islamic and Institutions To Modern Indonesian. *Pagaruyuang Law Journal*, 7(1), 207–221. <https://doi.org/10.31869/plj.v7i1.4567>
- Vidra, A., & Németh, Á. (2018). Bio-produced acetic acid: A review. *Periodica Polytechnica Chemical Engineering*, 62(3), 245–256. <https://doi.org/10.3311/PPch.11004>
- Walker, G. M., & Walker, R. S. K. (2018). Enhancing Yeast Alcoholic Fermentations. In *Advances in Applied Microbiology* (Vol. 105). Elsevier Ltd. <https://doi.org/10.1016/bs.aambs.2018.05.003>