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Literature review: Safety aspects and halal status of Kombucha

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Abstract
Kombucha is a fermented tea beverage produced by a symbiotic culture of bacteria and yeast (SCOBY) and is increasingly consumed as a functional beverage. However, concerns regarding its safety and halal status remain, particularly due to ethanol formation during fermentation. This review aimed to evaluate the safety aspects and halal compliance of Kombucha by analyzing fermentation conditions, microbial activity, alcohol production, and halal critical control points. A literature review approach was employed using scientific articles, conference proceedings, fatwas, and official regulatory documents retrieved from PubMed, ScienceDirect, and Google Scholar. The findings revealed that fermentation temperature, pH, duration, substrate composition, and microbial diversity significantly affected kombucha quality, particularly ethanol concentration and microbiological safety. Kombucha was generally considered safe for healthy individuals when produced under hygienic, controlled conditions. In contrast, uncontrolled fermentation increased the risk of excessive alcohol formation and microbial contamination. From a halal perspective, Kombucha may be considered permissible when ethanol content remains below 0.5%, and all ingredients and processing stages comply with halal requirements. Therefore, standardized fermentation control and halal assurance practices are essential to ensure product safety and halal compliance.

Keywords: Ethanol Content, Fermentation, Food Safety, Halal Compliance, Kombucha.

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1. Introduction

Kombucha is a traditional fermented beverage that originated in East Asia and later spread to various regions of the world, including Europe, particularly Germany via Russia, around the early 20th century. In recent decades, Kombucha has gained increasing global popularity due to its perceived health benefits and its classification as a functional beverage. Kombucha is produced by fermenting sweetened tea with a symbiotic culture of bacteria and yeast, commonly referred to as SCOBY (Symbiotic Culture of Bacteria and Yeast). This microbial consortium forms a cellulose-based biofilm on the surface of the fermentation medium, creating a distinctive gelatinous layer characteristic of kombucha fermentation (Chakravorty et al., 2016).

The growing consumer awareness of health and wellness has significantly driven demand for functional foods and beverages, including fermented products such as Kombucha. Functional beverages are defined as drinks that provide additional health benefits beyond basic nutrition, often due to the presence of bioactive compounds. Kombucha is considered one of the most promising functional beverages due to its

complex composition of beneficial metabolites produced during fermentation(das Chagas et al., 2024). These include polyphenols, organic acids (such as acetic acid, gluconic acid, and glucuronic acid), vitamins (especially B-complex vitamins and vitamin C), essential amino acids, enzymes, and antimicrobial compounds (Bishop et al., 2022).

During fermentation, yeast and bacteria work synergistically to convert sugars into various metabolites. Yeasts initially hydrolyze sucrose into glucose and fructose, which are subsequently metabolized into ethanol and carbon dioxide. Acetic acid bacteria, primarily from the genus Acetobacter and Gluconobacter, then oxidize ethanol into organic acids (Jayabalan et al., 2014). This sequential metabolic activity not only contributes to the characteristic sour taste of Kombucha but also enhances its functional properties(Marsh et al., 2014). Additionally, enzymatic activities such as vinyl phenol reductase and ferulic acid reductase play an important role in transforming phenolic compounds, leading to the formation of bioactive substances with antioxidant properties (Zubaidah et al., 2019).

Phenolic compounds, such as cinnamic acid and its derivatives, are known to function as natural antioxidants. These compounds can neutralize free radicals, thereby preventing oxidative stress and cellular damage (Chandrasekar et al., 2022). Oxidative stress is widely associated with the development of various chronic diseases, including cancer, cardiovascular diseases, and neurodegenerative disorders. Therefore, the antioxidant capacity of Kombucha is considered one of its most important health-promoting attributes (Liguori et al., 2018).

Numerous studies have reported the potential health benefits of Kombucha. For instance, Kombucha has been shown to exhibit anticancer activity by inhibiting cancer cell proliferation (Jayabalan et al., 2014). It also demonstrates antidiabetic effects by improving glucose metabolism and reducing blood sugar levels(Aloulou et al., 2012). Furthermore, Kombucha contains probiotics derived from lactic acid bacteria and yeast, which help maintain gut microbiota balance and improve digestive health. A healthy gut microbiome is closely linked to improved immune function, nutrient absorption, and overall well-being.

In addition to its probiotic content, Kombucha is rich in antioxidant compounds, including polyphenols, vitamin C, and glucuronic acid. These compounds play a crucial role in detoxification processes and in protecting the body against oxidative damage (Jakubczyk et al., 2020). Previous studies have also indicated that kombucha consumption may contribute to enhanced immune response (Ulfah et al., 2015), reduction of inflammation, improvement of joint conditions such as rheumatism (Jayabalan et al., 2014), antihypertensive effects (Aloulou et al., 2012), and antimicrobial activity against pathogenic microorganisms (Fadhilah et al., 2024).

Despite its numerous health benefits, kombucha production involves a fermentation process that generates ethanol as an intermediate metabolite. The presence of ethanol in Kombucha raises concerns, particularly in the context of halal compliance for Muslim consumers. According to the standards set by the Indonesian Ulema Council (Majelis Ulama Indonesia/MUI), the permissible alcohol content in beverages is less than 0.5%.

Any product exceeding this threshold is considered non-halal and unsuitable for consumption by Muslims (Majelis Ulama Indonesia, 2018).

The ethanol content in Kombucha is influenced by factors such as fermentation duration, temperature, sugar concentration, and the composition of the microbial community within the SCOBY. Under uncontrolled fermentation conditions, ethanol levels may exceed acceptable limits, thereby compromising the product's halal status. This issue highlights the importance of controlling fermentation parameters to ensure that Kombucha remains safe and compliant with halal standards (Majidah et al., 2022).

In addition to alcohol content, the safety of Kombucha is also determined by its microbiological quality. The fermentation process involves the growth of various microorganisms, some of which may pose a risk if contamination occurs (Jayabalan et al., 2014). While beneficial bacteria and yeast dominate the fermentation process under controlled conditions, improper handling or environmental contamination may lead to the proliferation of pathogenic microorganisms. Therefore, maintaining hygienic production conditions and monitoring microbial activity are essential to ensure product safety.

Fermentation conditions play a critical role in determining the final characteristics of Kombucha. Temperature, for example, affects microbial metabolism and enzyme activity. Higher temperatures may accelerate fermentation but can also lead to excessive acid production and higher ethanol levels (Chakravorty et al., 2016). Conversely, lower temperatures may slow fermentation and lead to incomplete sugar metabolism. Similarly, pH is an important factor that influences microbial growth and the stability of the fermentation process. A low pH environment is generally favorable for inhibiting pathogenic microorganisms, but must be carefully controlled to maintain product quality (Bishop et al., 2022).

Fermentation duration is another key parameter that significantly affects the chemical composition of Kombucha. Short fermentation periods may result in lower concentrations of organic acids and bioactive compounds, while prolonged fermentation can lead to excessive acidity and undesirable sensory characteristics. Moreover, extended fermentation may increase ethanol concentration before it is fully oxidized into organic acids. Therefore, determining the optimal fermentation time is crucial to achieving a balance between safety, quality, and halal compliance (Jayabalan et al., 2014).

The type and composition of microorganisms present in the SCOBY also influence the fermentation outcome. Different strains of yeast and bacteria exhibit varying metabolic activities, which can affect the production of ethanol, organic acids, and other metabolites. Understanding the interactions between these microorganisms is essential for optimizing the fermentation process and ensuring consistent product quality (Marsh et al., 2014).

Although numerous studies have explored the health benefits and biochemical properties of Kombucha, few have specifically examined the relationship between fermentation conditions and halal compliance. Most existing studies emphasize the nutritional and functional aspects of Kombucha, but do not adequately address alcohol content in relation to halal standards. This represents a significant research gap,

particularly in countries with large Muslim populations such as Indonesia, where halal certification is an important consideration for food and beverage products.

Furthermore, there is a lack of comprehensive studies that simultaneously evaluate both the safety and halal aspects of Kombucha under different fermentation conditions. Previous research tends to focus on either microbiological safety or chemical composition, but rarely integrates these aspects into a holistic assessment. As a result, there is a need for a more integrated approach that considers both safety and halal requirements in kombucha production.

The growing demand for halal-certified functional beverages presents an opportunity to develop kombucha products that meet both health and religious requirements. However, achieving this objective requires a thorough understanding of how fermentation conditions influence the formation of ethanol and other metabolites. By optimizing these conditions, it is possible to produce Kombucha with controlled alcohol levels while maintaining its beneficial properties.

Based on the aforementioned considerations, this study aims to investigate the influence of fermentation conditions, including temperature, pH, fermentation duration, and microbial composition, on the safety and halal status of Kombucha. This research focuses on analyzing the chemical characteristics, particularly ethanol content, and the microbiological quality of the final product. The findings of this study are expected to contribute to the development of standardized fermentation processes that ensure the production of safe, high-quality, and halal-compliant Kombucha.

In addition, this research is expected to provide valuable insights for producers, researchers, and regulatory bodies in establishing guidelines for kombucha production that align with halal standards. By addressing the existing research gap, this study advances knowledge in the field of functional beverages and supports the growing halal industry. Ultimately, the development of halal-compliant Kombucha could expand its market reach and increase consumer confidence, particularly among Muslim communities.

2. Research Method

This study employed a literature review approach to analyze the safety aspects and halal status of Kombucha. Literature sources were obtained from scientific journal articles, conference proceedings, official regulations, fatwas, and relevant official websites. The literature search was conducted through online databases, including PubMed, ScienceDirect, and Google Scholar.

The search was conducted using combinations of the keywords "kombucha", "halal", "alcohol", "ethanol", "food safety", and "fermentation". Articles published between 2014 and 2025 were considered for inclusion in this review. The inclusion criteria comprised: (1) publications discussing kombucha fermentation, safety aspects, alcohol content, and halal issues; (2) articles published in English or Indonesian; and (3) full-text articles accessible to the authors. Publications unrelated to the objectives of the study, duplicate articles, and articles without complete text were excluded.

A total of 54 articles were initially identified. After screening titles, abstracts, and full texts based on the inclusion and exclusion criteria, 29 relevant publications were

selected for further analysis. Additional references were obtained manually from the reference lists of selected articles and official regulatory documents. The selected literature was then analyzed descriptively to synthesize information regarding fermentation conditions, safety concerns, alcohol formation, and halal critical points in kombucha production.

3. Results and Discussion

Overview of Kombucha Fermentation

Kombucha is produced by fermenting sweetened tea with a symbiotic culture of bacteria and yeast (SCOBY). Sugar serves as the primary substrate and energy source for microbial growth during fermentation (Kaewkod et al., 2019). The tea brewing process aims to extract phenolic compounds, color, aroma, and flavor that contribute to Kombucha's antioxidant properties. However, brewing conditions, particularly temperature and time, significantly affect the extraction efficiency of bioactive compounds. Excessive brewing may degrade antioxidant compounds, whereas insufficient brewing may result in suboptimal extraction (Jakubczyk et al., 2020). After the addition of sugar, the tea solution is cooled to room temperature (20–25°C) and transferred into a sterile fermentation vessel before inoculation with SCOBY (Antolak et al., 2021).

The fermentation process involves a complex interaction between yeasts and bacteria. Yeasts, mainly *Saccharomyces* and several non-*Saccharomyces* species such as *Zygosaccharomyces*, *Candida*, *Pichia*, and *Brettanomyces*, convert sugars into ethanol and carbon dioxide, contributing to flavor development (Chakravorty et al., 2016; Sun & Ho, 2005). Acetic acid bacteria, including *Acetobacter* spp., *Gluconobacter* spp., and *Komagataeibacter* spp., subsequently oxidize ethanol into organic acids, thereby reducing alcohol concentration and producing the characteristic acidic taste of Kombucha (Suharman et al., 2024). These microorganisms coexist within SCOBY, a cellulose-based biofilm that also contributes to the production of vitamins, amino acids, enzymes, and probiotic compounds beneficial to human health (Firdaus, Indah, & Isnaini, 2020).

Fermentation generally lasts for 7–12 days under controlled conditions. During this period, microbial metabolism leads to the accumulation of various metabolites, including organic acids, vitamins, and bioactive compounds, as well as ethanol as an intermediate product (Majidah et al., 2022; Pratama et al., 2015). Since ethanol formation is an inevitable part of kombucha fermentation, controlling fermentation conditions is essential to ensure product safety and halal compliance. The general process of kombucha production is illustrated in Figure 1.

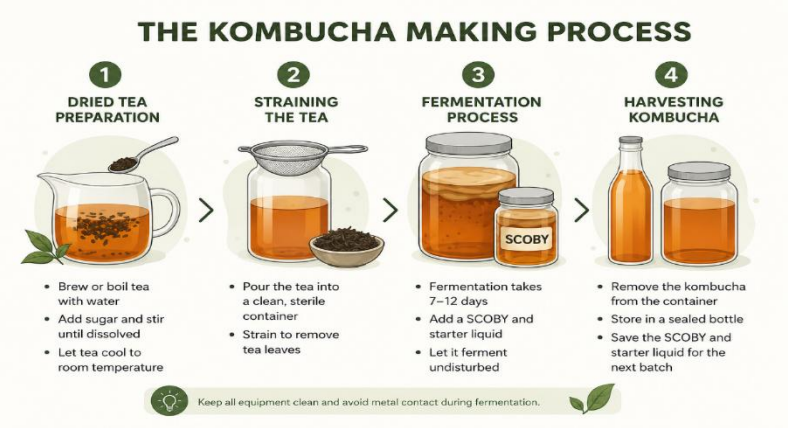

Figure 1. Kombucha Tea Making Process Generated by Canva

In the early stages, fermentation is carried out with aeration, which supports the growth of aerobic acetic acid bacteria. Then, fermentation is carried out in a closed bottle to support the growth of a facultative anaerobic yeast. The concentration of yeast cells in the liquid is generally higher than that found in pellets. In the growth of Potato Dextrose Agar (PDA) media, there are two types of colonies. This shows that there are two types of yeast found in Kombucha. The types of yeast that grow in Kombucha are generally Zygosaccharomyces and Saccharomyces. Similar results were also observed in acetic acid bacteria, which showed higher amounts in solution than in the pellicle (Majidah et al., 2022).

Fermentation Conditions and Their Influence on Kombucha Safety

Several studies have demonstrated that fermentation conditions significantly influence the safety characteristics of Kombucha. Fermentation temperature affects microbial metabolism, organic acid production, and ethanol formation. Fermentation temperature and duration are among the most important factors influencing the safety characteristics of Kombucha because they affect microbial metabolism, organic acid production, and ethanol formation. Higher fermentation temperatures may accelerate microbial activity, leading to increased ethanol production, whereas prolonged fermentation can alter ethanol concentration over time. During the initial stages, ethanol levels generally increase due to yeast metabolism; however, subsequent oxidation by acetic acid bacteria may reduce alcohol concentration as fermentation progresses. These findings indicate that fermentation temperature and duration should be carefully controlled to ensure product safety and maintain ethanol concentrations within acceptable halal limits (Chakravorty et al., 2016; Nyhan et al., 2022).

Temperature is considered one of the most critical factors affecting kombucha fermentation because it directly influences the growth and metabolic activity of both yeasts and acetic acid bacteria. Acetic acid bacteria generally grow optimally at temperatures ranging from 25 to 30° C, whereas excessively high temperatures may accelerate sugar metabolism and increase ethanol and organic acid accumulation(Chakravorty et al., 2016; Ismail et al., 2023). Conversely, temperatures that are too low may slow microbial activity, resulting in incomplete fermentation and

inconsistent product quality (Antolak et al., 2021). Therefore, maintaining an optimal fermentation temperature is essential to producing a stable, safe beverage.

The pH of Kombucha also plays an important role in determining microbiological safety. During fermentation, yeasts and acetic acid bacteria produce organic acids that gradually lower the beverage's pH (Jayabalan et al., 2014). A low pH environment inhibits the growth of pathogenic microorganisms and contributes to the antimicrobial activity of Kombucha (Bishop et al., 2022). However, excessively prolonged fermentation may reduce pH to undesirable levels, resulting in excessive acidity and potential adverse health effects among sensitive consumers (de Oliveira et al., 2023). Consequently, regular pH monitoring is required to balance product safety, quality, and consumer acceptability.

Fermentation duration is another factor that affects kombucha safety and halal compliance. Previous studies consistently reported that fermentation generally lasts 7-12 days, during which microbial metabolism produces various metabolites, including organic acids, vitamins, and ethanol (Majidah et al., 2022; Pratama et al., 2015). Ethanol concentration tends to increase during the initial fermentation stages due to the activity of *Saccharomyces* spp. that convert sugars into ethanol and carbon dioxide (Nyhan et al., 2022). Nevertheless, as fermentation progresses, acetic acid bacteria oxidize ethanol into acetic acid, thereby reducing alcohol concentration (Jayabalan et al., 2014). Under uncontrolled fermentation conditions, particularly in home-scale production, ethanol accumulation may exceed the halal threshold set by the Indonesian Ulema Council (Majelis Ulama Indonesia, 2018), underscoring the need to determine an optimal fermentation period.

In addition to environmental factors, the composition and diversity of microorganisms present in SCOBY significantly affect the chemical and microbiological characteristics of Kombucha. Kombucha fermentation involves various yeast species, including *Saccharomyces*, *Zygosaccharomyces*, *Candida*, and *Pichia*, as well as acetic acid bacteria such as *Acetobacter*, *Gluconobacter*, and *Komagataeibacter* (Chakravorty et al., 2016; Sun & Ho, 2005). Variations in microbial diversity may lead to differences in ethanol production, acidity, and bioactive compound formation (Kaewkod et al., 2019). Although microbial diversity contributes to Kombucha's functional properties, it also poses challenges for standardizing product quality and safety. Therefore, the use of well-characterized starter cultures and controlled fermentation conditions is strongly recommended to ensure consistent product quality, safety, and halal compliance.

Safety Aspects of Kombucha

The safety of Kombucha has attracted considerable attention due to the variability in its microbial composition and fermentation conditions. The microbial consortium involved in kombucha fermentation may vary with tea type, sugar concentration, fermentation temperature, and fermentation duration, leading to differences in chemical composition and microbiota profiles among products (Kaewkod et al., 2019). Such variability makes it difficult to ensure consistent health benefits and product quality (Jayabalan et al., 2014).

Safety concerns are particularly relevant in home-scale kombucha production, where fermentation conditions are often not standardized. Unlike industrial-scale production, homemade Kombucha is frequently produced without strict control of temperature, pH, fermentation time, and substrate composition, thereby increasing the risk of microbial contamination and excessive alcohol formation. Consequently, the establishment of standardized production guidelines is essential to improve product safety, especially for small-scale producers and household consumers.

Although Kombucha is generally considered safe when produced hygienically and consumed in moderation, several adverse effects have been reported. Clinical evidence regarding the safety of Kombucha in humans remains limited, and some ongoing studies investigating its effects on gut microbiota and metabolic health have yet to report conclusive findings. Nevertheless, case reports have documented adverse reactions such as allergic responses, nausea, vomiting, jaundice, headache, metabolic acidosis, and acute kidney failure, particularly among immunocompromised individuals and consumers with underlying medical conditions (Kole et al., 2009; Srinivasan et al., 1997).

In contrast, experimental studies have demonstrated a favorable safety profile of Kombucha under controlled conditions. A 90-day oral toxicity study in rats reported no signs of toxicity following regular kombucha consumption, suggesting that Kombucha is generally safe when produced and consumed appropriately (de Miranda et al., 2022). These findings indicate that the potential health risks associated with Kombucha are more likely related to improper fermentation practices, contamination, excessive consumption, or individual health status rather than the beverage itself. Clinical evidence regarding the long-term safety and health effects of Kombucha in humans remains limited, highlighting the need for further well-designed clinical studies. (de Miranda et al., 2022; Jayabalan et al., 2014).

Overall, the available literature suggests that Kombucha can be safely consumed by healthy individuals when manufactured under hygienic and controlled conditions. However, individuals with weakened immune systems, pregnant women, and consumers with specific medical conditions should exercise caution due to the potential risks associated with microbial contamination, excessive acidity, and alcohol formation.

Halal Status and Critical Control Points in Kombucha Production

In Islamic teachings, a Muslim is commanded to consume halal food as stated in QS Al-Baqarah:168 and HR Muslim 1015. In addition to the commandments of Allah SWT in the Qur'an and Hadith, halal products are also regulated by Law No. 33 of 2014 on halal product assurance (JPH). In the process, the fermentation of tea and sugar solutions produces a by-product: alcohol. According to MUI Fatwa Number 10 of 2018 concerning Food and Beverage Products Containing Alcohol/Ethanol, it is stated that a drink can be said to be halal if the alcohol/ethanol (C_2H_5OH) is less than 0.5% (Majelis Ulama Indonesia, 2018).

In a study by Pratiwi et al., the kombucha fermentation process generally showed an increase in alcohol content from the fourth to the 12th day. However, after an

increase on the 12th day, it decreased again on the 16th day. The increase in alcohol content is because, during the fermentation process, yeast Saccharomyces cerevisiae produces alcohol anaerobically; then, alcohol stimulates the growth of Acetobacter xylinum to produce acetic acid aerobically, while acetic acid stimulates the growth of Saccharomyces cerevisiae. Then, bacteria of the genus Acetobacter use alcohol to produce acetic acid, thereby decreasing the alcohol content (Nyhan et al., 2022). Kombucha products can be considered halal if their production process demonstrates that they are produced from a halal series from start to finish (Priyono & Riswanto, 2021).

Several kombucha products are late in obtaining halal certificates from MUI; for example, a localbrew product with halal certification number 03120030851019. The existence of kombucha tea products that have received halal certificates demonstrates that kombucha tea, along with its derivative products, meets the requirements and passes the feasibility tests conducted by LPOM MUI. Research on the determination of ethanol (alcohol) levels in kombucha tea conducted by (Lilis & Imas, 2022) with the title of the research on Kombucha, physicochemistry and a critical study of the halal level that uses black tea and green tea as a substrate medium, the result was an ethanol (alcohol) content of 0.48% which is close to the halal limit of halal consumption which is 0.5%. The concentration of alcohol in a product can be reduced in several ways, including dilution, pasteurization, distillation, and filtering bacteria or yeasts that produce alcohol, so that the alcohol content produced is below the standard of 0.5% (Kim & Adhikari, 2020).

In addition to the alcohol content, the critical points of each ingredient used in the manufacture of Kombucha must be closely monitored. A study by Lilis et al. (2022) identified a critical point for each ingredient used in Kombucha production. The ingredients used to make Kombucha include water as a solvent, tea, sugar, and a scoby culture. The critical point in water purification is the use of activated carbon. Commonly used activated carbon is usually derived from wood, coal, and coconut shells. However, some activated carbons derived from animal bones are not halal. In general, tea does not have a critical point because during tea preparation, only the tea shoots are dried without the addition of any substances. Make sure the tea used has a BPJPH halal logo.

Sugar used as a carbon source in the fermentation process has a critical point during manufacturing, namely the enzyme-based refining step. The enzymes used in this refining process can be derived from plants, animals, and microorganisms. If the enzyme used is derived from animals, it must be ensured that the animal's source and method of slaughter comply with Islamic law. If the enzyme is of microbial origin, ensure that the media and process auxiliary materials do not contain haram materials. The kombucha starter culture (SCOBY) used must be derived from microbes safe for humans. The critical points for microbes are the source of the gene and the substrate or growth medium used, whether halal or haram (Lilis & Imas, 2022).

Implications for Safe and Halal Kombucha Production

The findings of this review highlight the importance of implementing standardized fermentation practices to ensure both the safety and halal compliance of kombucha products. Variations in fermentation conditions, microbial composition, and raw materials may significantly affect ethanol concentration, microbiological quality, and overall product consistency. Therefore, establishing standardized production protocols, including control of temperature, pH, fermentation duration, and microbial cultures, is essential to minimize safety risks and maintain ethanol levels within acceptable halal limits.

From an industrial perspective, manufacturers should adopt Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Point (HACCP) systems to ensure hygienic production and prevent microbial contamination. In addition, implementing a comprehensive halal assurance system covering raw materials, processing aids, microbial cultures, production facilities, and packaging materials is necessary to maintain the halal integrity of kombucha products throughout the supply chain.

For regulatory authorities, the increasing popularity of Kombucha as a functional beverage necessitates the development of specific guidelines regarding permissible ethanol levels, labeling requirements, and quality standards. Clear regulatory frameworks are essential to protect consumers and facilitate halal certification processes, particularly in Muslim-majority countries.

The literature review also identified several research gaps. Most existing studies have focused on the biochemical and functional properties of Kombucha, whereas limited attention has been given to integrating safety and halal considerations. Furthermore, evidence regarding the long-term safety of kombucha consumption in humans remains limited. Future studies should therefore focus on establishing standardized fermentation conditions that minimize ethanol formation while preserving Kombucha's functional properties, as well as on conducting well-designed clinical studies to evaluate its long-term health effects.

Overall, integrating controlled fermentation practices, food safety principles, and halal assurance systems will support the development of safe, high-quality, and halal-certified kombucha products, thereby increasing consumer confidence and expanding market opportunities in the global halal industry.

4. Conclusion

Kombucha is a promising functional beverage with potential health benefits attributed to its bioactive compounds and probiotic microorganisms. However, its safety and halal status are highly influenced by fermentation conditions, including temperature, pH, fermentation duration, and microbial composition. Improper or uncontrolled fermentation may increase the risk of microbial contamination and excessive ethanol formation, thereby compromising both product safety and halal compliance. The reviewed literature indicates that Kombucha is generally safe for healthy individuals when produced under hygienic and controlled conditions and consumed in moderation. Nevertheless, caution should be exercised by immunocompromised individuals and

consumers with specific health conditions due to the potential adverse effects associated with excessive acidity, contamination, and alcohol formation.

From a halal perspective, Kombucha may be considered permissible when ethanol concentrations remain below the threshold established by the Indonesian Ulema Council and when all raw materials, processing aids, microbial cultures, and production processes comply with halal requirements. Therefore, implementing standardized fermentation practices, food safety principles, and comprehensive halal assurance systems is essential to ensure the production of safe, high-quality, and halal-compliant kombucha products. Further research is required to establish standardized fermentation protocols, evaluate the long-term safety of kombucha consumption in humans, and strengthen scientific evidence on integrating food safety and halal principles into kombucha production.

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