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Critical points halal of fermented beverage products

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ABSTRACT
Public awareness of the importance of health is increasing, leading to higher consumption of functional products such as fermented beverages. Kombucha, kefir, and fermented milk are among the most popular fermented products. However, several aspects can become critical points for ensuring their halal status. This paper aims to identify the halal-critical points of fermented beverages, particularly kombucha, kefir, and fermented milk, with a focus on the use of starter cultures and their impact on the final product. A common critical point across these products is the fermentation duration, which directly affects alcohol content. According to Fatwa MUI No. 10 of 2018, fermented products remain halal if the alcohol content does not exceed 0.5%. For kombucha and water kefir, the critical points lie in the halal status of the water and sugar used, as well as the source of the starter culture or SCOBY in kombucha. In the case of milk kefir and fermented milk, the type and source of milk represent critical points. Furthermore, microbial sources and growth media derived from non-halal or impure materials are also considered critical points, as regulated under MUI Fatwa No. 01 of 2010.

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Alcohol content, Fermented beverages, Halal.

INTRODUCTION

Food is a primary need for humans that has been classified in the Quran as halal and thayyib (Aziz et al., 2023). In this context, the Quran emphasizes the importance of Muslims consuming food and drink that are both halal and thayyib (good and wholesome). Halal and thayyib mean that the food consumed must be free from haram elements such as pork, blood, intoxicating alcohol, and other ingredients prohibited by Islamic law. This command regarding halal food and thayyib is mentioned in the Quran, including in Surah Al-Baqarah, verse 173, and Surah Al-Maidah, verse 90, which guides Muslims to consume food that is not only legally halal but also beneficial for health. Therefore, halal food is not only related to the type of ingredients used but also includes how these ingredients are obtained, processed, and served in line with Islamic ethical and hygienic standards (Aziz et al., 2023).

The increasing awareness of public health has shifted consumer preferences toward functional beverages, particularly fermented drinks such as kombucha, kefir, and fermented milk (Taupiqurrohman et al., 2024; Yuliana et al., 2023). These beverages are produced through microbial fermentation, which enhances their nutritional and functional properties by generating bioactive compounds, including vitamins, enzymes, and prebiotics (Ayed et al., 2020). However, the fermentation process also produces alcohol as a by-product, which raises concern for Muslim consumers all over the world, where halal compliance is essential.

Although fermented beverages offer health benefits, their halal status remains a significant concern due to factors such as the sources of raw materials, microbial cultures, growth media, and fermentation conditions. Several studies have reported varying alcohol contents in fermented beverages depending on the substrate, fermentation duration, and microbial starter used (Rosyada et al., 2023;

P-ISSN: 2715-6214
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Shafira et al., 2022; Sulistiawaty & Solihat, 2022). According to MUI Fatwa No. 10 of 2018, foods and beverages with alcohol content below 0.5% are still considered halal. Thus, it is critical to identify the points in the production process that may affect halal status.

The purpose of this study is to identify and analyze the halal critical points of kombucha, kefir, and fermented milk, focusing on the use of starters, growth media, and fermentation duration. The expected outcome is a practical mapping of halal critical points that can serve as a guideline for producers in developing halal-compliant fermented beverages. The contribution of this study lies in providing a systematic framework for halal risk assessment in fermented beverage production, bridging the gap between scientific evidence and Islamic regulatory standards.

RESEARCH METHOD

Data Analysis

This study employed a literature review approach. Data were collected from journal articles, conference proceedings, fatwas, and official documents relevant to halal fermented beverages. Literature searches were conducted using online databases such as ScienceDirect and Google Scholar, with the following keywords: "halal," "kombucha," "kefir," "fermented milk," and "alcohol." Additional sources were obtained manually from relevant libraries. The inclusion criteria focused on studies published in the last 10 years and fatwas or regulations issued by the Indonesian Ulema Council (MUI) related to halal food and beverages. The analysis emphasized identifying raw materials, microbial sources, fermentation conditions, and alcohol content as potential halal critical points.

RESULT AND DISCUSSION

The halal critical point of a product is a stage in the production process that may change its halal status to haram. The selection of critical control points is based on halal regulations, particularly Fatwa MUI No. 01/2010 and the Decree of the Minister of Religion of the Republic of Indonesia No. 748/2021, combined with supporting scientific evidence regarding the potential introduction of haram or impure substances at each stage of the process. These critical points can be identified through the analysis of raw materials, microbial sources, microbial growth media, fermentation conditions, and the final alcohol content of the product (Atma et al., 2018). Fermented beverages, including kombucha, kefir, and fermented milk, are produced through microbial metabolism, which naturally generates ethanol as a by-product (Sulistiawaty & Solihat, 2022). According to MUI Fatwa No. 10 of 2018, foods and beverages containing less than 0.5% ethanol are still categorized as halal.

Table 1 summarizes alcohol contents from various studies, showing how raw materials, fermentation duration, and inoculum concentration affect the final ethanol level. For instance, kefir made from goat milk produced 0.60 – 1.78% ethanol (Sulmiyati et al., 2019), which exceeds the halal limit, while kefir from UHT cow's milk produced 0.28 – 0.31% ethanol (Fitrianingsih et al., 2022), which remains within the halal threshold. Identifying critical points in fermented food production is essential for ensuring halal integrity throughout the process. Key control areas include verifying that all raw materials and auxiliary ingredients, such as water and sugar, are halal-certified and free from haram substances, particularly since purification methods may involve animal-derived materials (Sulistiawaty & Solihat, 2022). Microbial starters and growth media are another major concern, as only cultures grown in halal-certified media are permissible; media like MRS agar may contain animal-based peptones of uncertain status (Hayek et al., 2019). Furthermore, careful regulation of the fermentation process and monitoring of alcohol content are crucial, as prolonged fermentation or increased sugar levels can lead to ethanol concentrations exceeding the 0.5% halal threshold (Rosyada et al., 2023; Shafira et al., 2022).

P-ISSN: 2715-6214
E-ISSN: 2964-4909

Table 1. Analysis of halal critical points for various types of fermented drinks.

Fermented beverage products	Type of raw material	Microbes and microbial growth media	Fermentation control process	Alcohol content	Critical Point
Kombucha from wuluh starfruit leaves (Rosyada et al., 2023)	Wuluh starfruit leaves	Scoby	Kombucha made with a sugar concentration of 10% and different fermentation times: P1: 0 day P2: 4 days P3: 8 days P4: 12 days	P1: 0.11% P2: 0.21% **P3: 0.82%** P4: 0.41%	Alcohol content
Green tea kombucha (Rukman & Haerussana, 2023)	Green tea leaves	Scoby	Kombucha is made of different sweeteners using a 10% concentration. The type of sweetener used is: P1: Refined sugar P2: Stevia P3: Honey P4: Palm sugar	**P1: 2.66%** **P2: 2.36%** **P3: 2.78%** **P4: 2.45%**	Alcohol content
Kombucha made from cascara arabica coffee (Shafira et al., 2022)	Arabica coffee cascara	Scoby	Kombucha made with high fructose syrup 5.5% and different fermentation times: P1: 2 days P2: 4 days P3: 6 days P4: 8 days	Kandungan alkohol **P1: 0.74%** **P2: 0.91%** **P3: 1.21%** **P4: 2.59%**	Alcohol content
Kombucha made from seaweed (Gustishio et al., 2023)	Seaweed	Scoby	Kombucha fermented for 7 days at room temperature with the addition of different sugar concentrations: P1: 9% P2: 10% P3: 11% P4: 12%	P1: 0.13% P2: 0.21% P3: 0.25% P4: 0.45%	-
Water kefir from green coconut water (Dwiloka et al., 2020)	Green coconut water	Grain water kefir	Water kefir is fermented with a grain concentration of 5% and at different times: P1: 12 hours P2: 24 hours P3: 36 hours P4: 48 hours	**P1: 1.16%** **P2: 1.96%** **P3: 2.80%** **P4: 4.14%**	Alcohol content
Water kefir from papaya, snake fruit, and pineapple (Kurniawidi & Utomo, 2021)	snake fruit (A1), pineapple (A2), and papaya (A3)	Grain water kefir	Water kefir is fermented with different grain concentrations: P1: 5% P2: 8% P3: 11%	**P1A1: 1.25%** **P2A1: 1.39%** **P3A1: 1.79%** **P1A2: 1.32%** **P2A2: 1.45%** **P3A2: 1.75%** **P1A3: 1.30%** **P2A3: 1.45%** **P3A3: 1.66%**	Alcohol content

P-ISSN: 2715-6214
E-ISSN: 2964-4909

Fermented beverage products	Type of raw material	Microbes and microbial growth media	Fermentation control process	Alcohol content	Critical Point
Kefir milk from various types of milk (Ayana & Saber, 2016)	Buffalo milk (A1), cow milk (A2), sheep milk (A3), goat milk (A4), soy milk (A5)	Kefir grains	Kefir milk is fermented with different % inoculum and incubation temperatures: Percent inoculum: P1: 2% P2: 4% Incubation temperature: T1: 24℃ T2: 28℃ Incubation time: 7 days	A1P1T1: 0.18% A1P2T1: 0.19% A1P1T2: 0.19% A1P2T2: 0.21% A2P1T1: 0.12% A2P2T1: 0.15% A2P1T2: 0.18% A2P2T2: 0.21% A3P1T1: 0.21% A3P2T1: 0.21% A3P1T2: 0.22% A3P2T2: 0.25% A4P1T1: 0.22% A4P2T1: 0.24% A4P1T2: 0.25% A4P2T2: 0.29% A5P1T1: 0.25% A5P2T1: 0.27% A5P1T2: 0.31% A5P2T2: 0.36%	
Milk kefir from goat milk (Sulmiyati et al., 2019)	Goat milk	Milk kefir grains	Percent inoculum: P1: 2% P2: 4% P3: 6% Incubation temperature: 37℃ Incubation time: 24 hours	P1: 0.69% P2: 1.41% P3: 1.78%	Alcohol content

P-ISSN: 2715-6214
E-ISSN: 2964-4909

Fermented beverage products	Type of raw material	Microbes and microbial growth media	Fermentation control process	Alcohol content	Critical Point
Milk kefir from UHT milk (Fitrianingsih et al., 2022)	UHT milk	Milk kefir grains	Different concentrations of milk kefir grains: P1: 2.5% P2: 5% P3: 7.5% P4: 10%	P1: 0.28% P2: 0.28% P3: 0.29% P4: 0.31%	-
Fermented vegetable milk from three different types of nuts (Meng et al., 2023)	Soy, peanut, and chickpea	*Lactobacillus fermentum* GD01 yang ditumbuhkan dalam media MRS	A type of plant-based milk from three different types of nuts: P1: soy P2: peanut P3: chickpea	-	Microbial sources and growth media
Fermented milk with various starter microbes (Marya et al., 2017)	Cow milk	*L. plantarum* Dad 13, *L. lactis*, *S. cerevisiae* (grown in MRS media), and *K. marxianus* (grown in YPG agar)	Milk was incubated at 37°C for 18 hours. The types of starters used are: K1: *L. plantarum* Dad 13 + *S. cerevisiae* K2: *L. plantarum* Dad 13 + *K. marxianus* K3: *L. plantarum* Dad 13 + *L. lactis* + *S. cerevisiae* K4: *L. plantarum* Dad 13 + L. lactis + *K. marxianus* K5: *L. lactis* + *S. cerevisiae* K6: *L. lactis* + *K. marxianus*	K1: 0.07% K2: 0.09% K3: 0.03% K4: 0.11% K5: 0.04% K6: 0.07%	Microbial sources and growth media

Critical Points in Kombucha

Kombucha is produced by fermenting tea with sugar and a SCOBY (symbiotic culture of bacteria and yeast). In considering the halal status, key points include the source of water and sugar, the halal status of SCOBY, and fermentation time. Notably, prolonged fermentation (> 8 days) generally increases alcohol levels beyond 0.5%, making the product non-halal unless controlled (Rukman & Haerussana, 2023). In terms of the fermentation process, it can occur due to the presence of various microorganisms. Research conducted by Landis et al. (2022), revealed that kombucha starters from different regions of the United States contained a diverse array of microorganisms, with acetic acid bacteria being the dominant bacteria, followed by lactic acid bacteria and yeast species. The presence of *K. rhaeticus* is often found in abundant amounts. The existence of diverse microorganisms demonstrates that kombucha fermentation is based on complex interactions between various microbes, which play a role in fermentation and contribute to the formation of the beverage's characteristics.

The kombucha-making does not require hard-to-obtain ingredients and equipment. According to Jayabalan et al. (2014), as cited in Dutta & Paul (2019), the kombucha-making process begins with boiling water and then adding sugar. Add the tea leaves, stir for 5 minutes, then strain and let the solution cool to room temperature. Add kombucha or pre-fermented vinegar until the pH is below 4.6. Then, add the SCOBY from the previous batch and finally cover the container with a paper towel. Fermentation proceeds for 8 to 15 days. A new SCOBY will form during this period. Taste the liquid periodically and bottle the kombucha in sterilized containers once the desired flavor is reached. The

P-ISSN: 2715-6214
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new SCOBY can be used for future batches. Figure 1 illustrates the halal critical points and process flow for brewing kombucha.

Key factors in the kombucha fermentation process include the selection of materials and processing methods. A primary consideration for halal quality in kombucha products is the source of water, particularly when activated carbon is utilized for purification. Activated carbon may be derived from non-halal animal bones, which compromises the halal status of the product if used in water purification (Sulistiawaty & Solihat, 2022). Additionally, sugar used as an auxiliary ingredient must be halal certified in accordance with the Decree of the Minister of Religion of the Republic of Indonesia, No. 748 of 2021. This requirement arises because sugar refining processes often employ ion exchange resins or blanching agents that may incorporate activated carbon from animal bones. To maintain the halal status of the final product, all animal-derived components must comply with Islamic law.

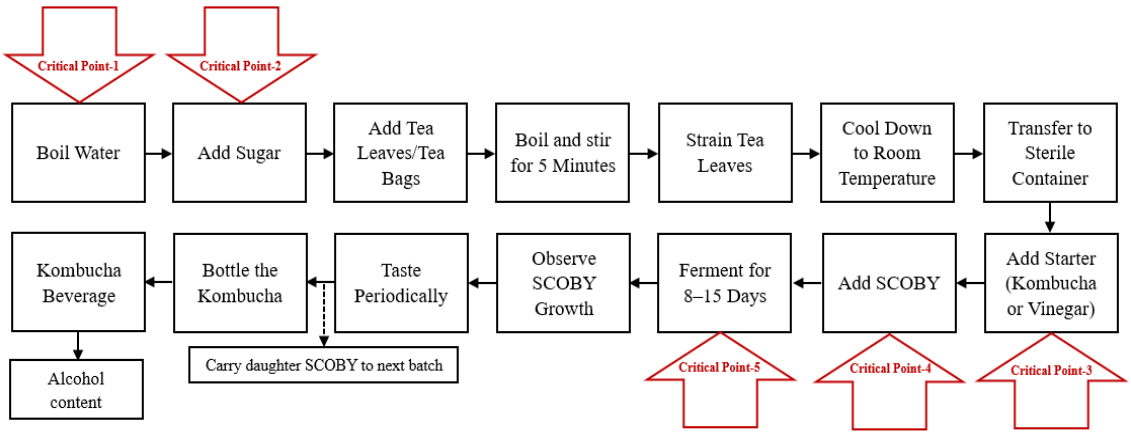

Figure 1. Critical points of halalness and process flow for making kombucha.

Microorganisms play a critical role in the fermentation process of kombucha production. The use of microbes and microbial products in food is regulated under Fatwa MUI No. 01 of 2010. Kombucha qualifies as a microbial product due to its production through microbial metabolic activity and the involvement of microbial cells, specifically the symbiotic culture of bacteria and yeast (SCOBY), which drives the fermentation process. It is essential to ensure that both the starter culture and the SCOBY remain uncontaminated by haram or impure substances. The use of a contaminated starter may compromise the halal status of the final product. According to Fatwa MUI, microbial products derived from microbes cultivated in impure media are considered haram unless purified. Consequently, the growth medium for SCOBY must be maintained in a pure state and free from any potentially non-halal ingredients.

The critical points in making kombucha are the fermentation process and the alcohol content produced. Alcohol in kombucha is produced when glucose in the tea solution is converted into ethanol. The increased alcohol levels are also caused by yeast activity, which produces the enzyme alcohol dehydrogenase that also converts sugar into alcohol. Prolonged fermentation increases both the intensity of the aroma and the alcoholic taste of the beverage (Sulistiawaty & Solihat, 2022). Therefore, controlling fermentation duration and selecting raw materials are essential for maintaining a low alcohol content. Alcohol produced in small quantities during fermentation is considered halal, provided it does not exceed the threshold established by the Indonesian Ulema Council (MUI) in Fatwa MUI no. 10 of 2018, which determines that foods and beverages must contain less than 0.5% alcohol or ethanol.

According to studies by Gustishio et al. (2023), Rosyada et al. (2023), Rukman & Haerussana (2023), Shafira et al. (2022). The alcohol content produced in kombucha depends on the raw materials, type of sweeteners, and fermentation duration. For instance, kombucha made from carambola leaves (Rosyada et al., 2023), showed an increase in alcohol content with longer fermentation times, emphasizing the need to control fermentation to maintain low alcohol levels. Likewise, in kombucha made from green tea leaves (Rukman & Haerussana, 2023), different sweeteners led to varying alcohol

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concentrations, highlighting the influence of sweetener type. Further supporting these patterns, Arabica coffee husk kombucha (Shafira et al., 2022), demonstrated rising alcohol levels during fermentation. In contrast, algae-based kombucha exhibited relatively lower alcohol content, peaking at 0.45% at a sugar concentration of 12%. These findings confirm that both fermentation time and ingredient choice significantly influence alcohol content, which is critical for maintaining the halal integrity of kombucha products.

Critical Points in Kefir

Kefir is generally categorized into water kefir and milk kefir. In water kefir, the critical factors are the type of fruit extract, the sugar source, and the fermentation duration. Research has shown that water kefir fermented for 48 hours can contain more than 4% ethanol (Dwiloka et al., 2020). In milk kefir, the type of milk and the concentration of starter culture determine its halal status. Higher concentrations of kefir grains result in increased ethanol levels (Setyawardani et al., 2014).

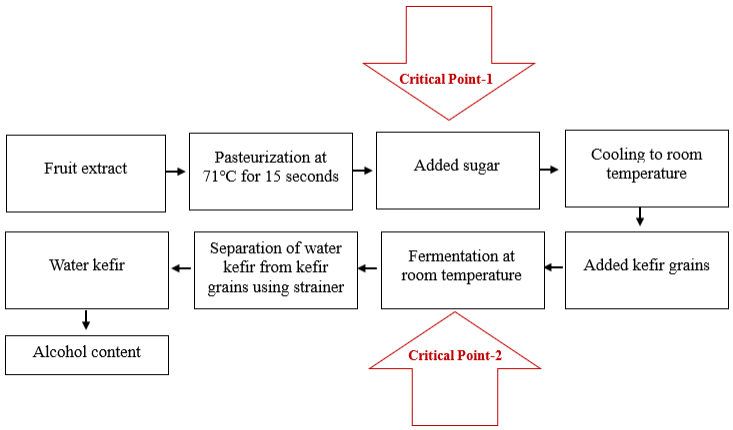

Figure 2. Halal critical points and process flow for making water kefir.

The production of water kefir relies on the use of kefir grains as the starter for fermentation. Water kefir can be prepared using a variety of basic ingredients, resulting in multiple variations of the product. Numerous studies have explored the use of different fruits in water kefir production. For example, Güzel-Seydim et al. (2023) utilized mandarin oranges and persimmons, Zannini et al. (2022) used apples, raisins, and dried figs, and Limbad et al. (2023) employed coconut water. According to Mulyani et al. (2021), the process begins with fruit extraction, followed by pasteurization of the extract at 71°C for 15 seconds. Sugar is then added to the pasteurized extract. Once the extract has cooled to room temperature, water kefir grains are added. Fermentation occurs at room temperature, and upon completion, the kefir grains are separated from the final product to halt fermentation. Figure 2 illustrates the halal critical points and the process flow for water kefir production.

The process of making milk kefir is like that of water kefir. According to Setiawati et al. (2021), the preparation of milk kefir begins with pasteurizing milk at 90°C for 10 minutes, followed by cooling to 25°C. The next key step is the addition of milk kefir grains and the fermentation at room temperature for 24 hours. After fermentation, the kefir is separated from the grains to stop the process, marking the final stage of production. While cow's milk is commonly used as the raw material, other types, such as buffalo milk Margareth et al. (2020) and goat's milk Melani et al. (2021), are also considered. The critical halal points and processes flow for producing water kefir are shown in Figure 3. Particular attention to both ingredients and processes in the production of water and milk kefir is essential for controlling halal-critical points. For instance, the water and sugar used in water kefir production may pose potential concerns, as they are sometimes processed using carbon derived from non-halal animal sources, such as bones.

P-ISSN: 2715-6214
E-ISSN: 2964-4909

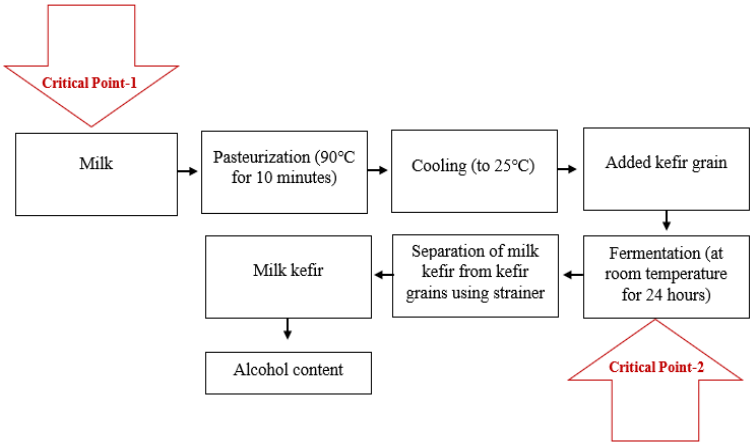

Figure 3. Halal critical points and process flow for making milk kefir.

The critical point of milk and water kefir products depends on the amount of alcohol produced during the fermentation process. According to Fatwa MUI No. 10 of 2018, the alcohol content in fermented foods and beverages must be 0.5% or lower; products exceeding this limit are categorized as haram. Research by Dwiloka et al. (2020) and Kurniawidi & Utomo (2021) reported that water kefir fermentation produces alcohol levels exceeding 1%. Similarly, kefir made from goat's milk, studied by Sulmiyati et al. (2019), contained 0.60 – 1.78% alcohol, which exceeds the permitted threshold. In contrast, kefir produced from UHT milk in the study by Fitrianingsih et al. (2022) exhibited alcohol levels of 0.28 – 0.31%, which remain within acceptable limits. The fermentation stage, therefore, represents a critical control point, as alcohol level can be managed by regulating the sugar concentration, the amount of kefir grains, and the fermentation duration.

Microorganisms in water kefir grains utilize sucrose from the substrate during fermentation, resulting in an increase in glucose and fructose concentrations after 72 hours (Esatbeyoglu et al., 2023). Within the first 24 hours, sucrose concentration decreases by about 98% (Martínez-Torres et al., 2017). This reduction occurs due to ethanol formation by yeast, in which invertase hydrolyzes sucrose into glucose and fructose, which are subsequently metabolized by lactic and acetic acid bacteria (Pendón et al., 2022). The addition of sucrose influences the alcohol content of the final product, as confirmed by Rizqiati et al. (2021), who reported that higher sucrose levels increase the alcohol content of water kefir. This is attributed to the ability of microorganisms to use sucrose as an energy source, thereby producing more alcohol. Furthermore, the type of fruit used also affects the formation of alcohol in water kefir. Vitamins and carbohydrates naturally present in fruit extracts promote yeast growth, which contributes to alcohol production (Yelnetty et al., 2023).

The concentration of grains used in the production of water and milk kefir directly affects the alcohol content of the final product. Determining an optimal grain concentration is essential to prevent the alcohol content from exceeding levels considered haram. Setyawardani et al. (2014) demonstrated that higher concentrations of kefir grains lead to increased alcohol production during fermentation, primarily due to a greater yeast population that metabolizes sugars and other substrates into alcohol. In milk kefir grains, *K. lactis* and *Torulaspora delbrueckii* are the primary yeasts responsible for alcohol production (Tantaleán et al., 2024), while *Saccharomyces cerevisiae* is most associated with water kefir grains (Hecer et al., 2019). Microbial diversity in kefir also evolves. Alraddadi et al. (2023) found that *Lactobacillus kefiranofaciens* and *Lentilactobacillus kefiri* consistently dominate kefir grains, whereas *Lactococcus lactis* is the predominant species in kefir.

Fermentation time is a critical factor to consider for the halal status of kefir, as alcohol levels increase with longer fermentation durations. Munajib (2021) reported that water kefir made from agarwood leaves fermented for 18, 21, and 24 hours contained 0.4%, 0.6%, and 0.8% alcohol, respectively. This increase is due to the consumption of substrates by microorganisms, which produce alcohol during the fermentation process. Over-extended fermentation periods, more substrates are

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consumed, leading to higher alcohol levels, although alcohol concentration may eventually decrease once the available substrates are depleted (Avila-Reyes et al., 2022).

Critical Points in Fermented Milk

Fermented milk is a dairy product produced through milk fermentation using appropriate and harmless microorganisms, where the microorganism culture will remain alive, active, and abundant in fermented milk, but will die if the fermented milk is heated (García-Burgos et al., 2020). In the process of making fermented milk, the main ingredient used is milk sourced from a cow, buffalo, goat, sheep, yak, horse, camel, or other animal, with *Lactobacillus* and *Bifidobacterium* as the common starters used for the fermentation process (Ma et al., 2023). Unlike fermented milk products such as yogurt and kefir, the fermented milk discussed in this article utilizes various bacterial strains or combinations, as demonstrated by research conducted by Meng et al. (2023) and Marya et al. (2017) (Table 1). The flow of the fermented milk-making process and its critical halal points are illustrated in Figure 4.

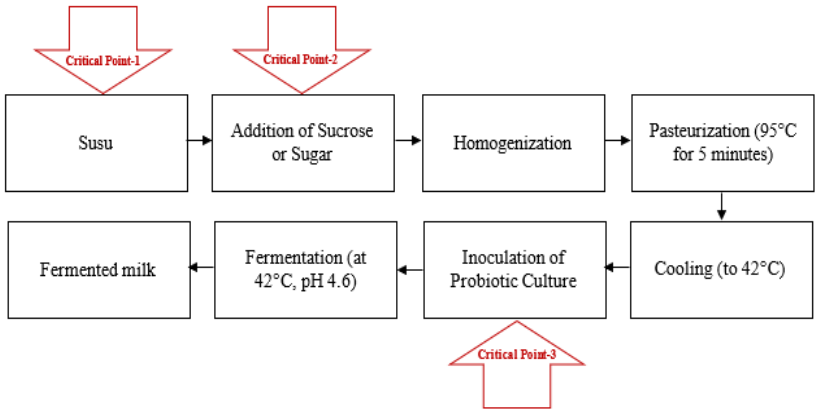

Figure 4. Critical points of halalness and the process flow of making fermented milk.

There are three critical points in the process of making fermented drinks. First, the milk used must come from halal-approved animals, such as cows, buffaloes, or goats, to ensure the fermented product meets halal requirements. Second, the sugar used as an ingredient comes only from sugar with proper halal certification, as mandated by the Decree of the Minister of Religion of the Republic of Indonesia No. 748 of 2021, due to the potential involvement of animal-derived components in the refining process. Third, the halal status of fermented drinks relies on the bacteria's source, growth medium, and derived metabolites. According to Fatwa MUI No. 01 of 2010, starter bacteria are considered halal only if they are cultivated in pure or halal-certified media. Non-halal or impure growth media, such as those derived from pork, result in product haram. Recent studies from Marya et al. (2017) and Meng et al. (2023), highlighted concerns regarding the standard *de Man Rogosa and Sharpe* (MRS) medium, which contains potentially ambiguous animal-derived ingredients (Hayek et al., 2019). Whose halal status is often unclear. Lastly, the use of bacterial strains with genes originating from non-halal animals can further complicate the halal integrity of the product (Sulistiawaty & Solihat, 2022).

The use of halal microbial growth media represents an alternative approach to maintaining the halal status of products. Recent studies have investigated various halal materials for media development, including peptone and plant-based enzymes. Rossi et al. (2022) demonstrated that a peptone-based medium derived from catfish waste and supplemented with bromelain enzymes from pineapple cores supports microbial growth. The growth of L. plantarum TMW 1.1623 in this medium was comparable to that observed in commercial MRS medium. Similarly, Ayu et al. (2023) reported that lactic acid bacteria, including L. plantarum TISTR 2075, Lpb. Lactobacillus plantarum MW3 and Lactobacillus casei TISTR 1463 exhibited robust growth in a medium formulated from sweet potato extract supplemented with 10 g/L soybean powder, which was comparable to commercial MRS medium. Additionally, Utami et al. (2020) described the use of halal media composed of sucrose, halal

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meat hydrolyzed with crude bromelain, bean sprout extract, tomato extract, and young coconut for large-scale production of fermented milk, providing another viable source of halal media.

CONCLUSION

This study concludes that the halal critical point in kombucha, kefir, and fermented milk is determined by raw materials, microbial sources, growth media, and fermentation time. Alcohol content exceeding 0.5% as a result of prolonged fermentation or high inoculum concentration is the primary factor that can change halal status to haram. Kombucha and water kefir are particularly sensitive to the halal status of water, sugar, and SCOBY or kefir grains, while milk kefir and fermented milk depend on the type and source of milk. Microbial growth media also play a vital role, as non-halal components in culture media may compromise the halal integrity of the final product. The contribution of this study lies in providing a practical framework for identifying halal critical points in fermented beverages, which can be used by producers, halal auditors, and regulators. By applying this framework, producers can better control raw materials and fermentation processes to ensure that their products comply with halal standards while still offering health benefits to consumers.

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