

Narrative review: A study of critical points of halalness of milk products and their derivatives



Irena Dwi Mulyaningtyas^{1*}, Aulia Rizki Maulani¹

¹Master of Food Science Study Program, Department of Food Science and Technology, Faculty of Agriculture Technology, Institut Pertanian Bogor University, Jl. Raya Dramaga, IPB Postgraduate School Building, IPB Dramaga Campus, Bogor, West Java, 16680, Indonesia

*Corresponding author: tyas123irena@apps.ipb.ac.id

ABSTRACT

Dairy products and their derivatives have high nutritional value and are widely consumed, but the complexity of their production processes poses potential risks of non-halal status. Various stages, such as milking, fermentation, enzyme addition, the use of additives, and packaging, can be critical points affecting halal status. This study aims to identify critical points for halal status in milk and dairy products, including yogurt, cheese, butter, ice cream, and probiotic drinks. The study was conducted through a literature review of scientific publications and official documents over the past ten years, focusing on raw materials, processing, additives, and potential contamination. The study results indicate that critical points in raw materials are primarily related to the milk source, its handling, and the hygiene of the process from milking to storage. In fermented products such as yogurt, kefir, and cheese, microbial growth media, starter cultures, and coagulant-forming enzymes are essential aspects that must be verified for halal status. Products such as butter and ice cream may contain critical points, especially in emulsifiers, stabilizers, flavors, colorings, and gelatin, which may be derived from non-halal animal sources. Furthermore, production processes such as pasteurization, ripening, churning, and freezing must ensure there is no cross-contamination with haram ingredients. Overall, identifying and controlling critical halal points at every stage of production is essential to ensure dairy products meet halal principles and are safe for consumption. This study provides a comprehensive mapping guide for the industry to ensure compliance with halal standards and provide assurance to consumers.

Article History

Submitted: October 29, 2024

Revised: December 8, 2025

Accepted: February 4, 2026

Published: February 28, 2026

Keywords

Halal MSMEs, Fishery products, House of risk, Risk mitigation, Supply chain risk.

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INTRODUCTION

Public awareness of a better quality of life is driving the choice of natural, functional foods, including dairy products. Milk is a rich source of protein and contains various fractions, including casein, whey, milk fat globules, enzymes, and other minor proteins. In addition to being a source of nutrition, milk protein has various physiological functions, while its bioactive compounds play a role in growth and development and provide antimicrobial activity (Susanti & Hidayat, 2016). Milk is a source of protein and calcium, both essential for health, making it widely consumed. However, with technological advances and the increasing complexity of production processes, the issue of halal dairy products requires further in-depth study (Jumiono et al., 2023).

The increase in dairy production not only facilitates consumption but also raises concerns about its quality and halal status. Product quality can decline due to milk spoilage, and the halal status can change if processing is not correctly managed. In the Islamic context, halal refers to products permitted

by Sharia law, particularly food and beverages. A product is considered halal if it does not contain prohibited ingredients, such as pork, blood, alcohol, or animals not slaughtered according to Sharia law (Nuraini, 2018). The Quran emphasizes the obligation of Muslims to consume food and drinks that are halal and thayyib, meaning products free from haram elements such as pork, blood, alcohol, and other substances prohibited by Islamic law. This principle is stated, among other things, in Surah Al-Baqarah: 173 and Surah Al-Maidah: 90, which guides Muslims in choosing foods that are both legally permissible and beneficial for health. The concept of halal-thayyib encompasses not only the type of ingredients but also the process of obtaining, processing, and serving them, which must comply with Islamic ethical and hygienic standards (Aziz et al., 2023). Therefore, it is crucial to have a thorough understanding of the halal status of dairy products to ensure they meet applicable safety and halal standards.

The risk of non-halal status in processed dairy products can be controlled by determining their critical halal status. A critical halal status for a food product is the stage of production at which the product could become haram. In addition to the production process, determining the critical halal status of processed dairy products can also be done through the raw materials, additives, and other ingredients used (Amen et al., 2020). Based on this description, a literature study was conducted to examine the critical halal points for milk and its derivatives. This study aims to identify and analyze the critical halal points for dairy products, focusing on main ingredients, processing, additives, and packaging. The expected outcome is a practical mapping of the critical halal points to guide producers in developing milk-based products that comply with halal standards. This study also provides a systematic framework for halal risk assessment that links scientific evidence with Islamic regulations.

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 dairy products and their derivatives. A literature search was conducted using online databases such as ScienceDirect and Google Scholar using the following keywords: "halal," "raw materials," "processing," "additives," and "packaging" found in dairy products and their derivatives. Additional resources were manually obtained from relevant literature. Inclusion criteria focused on studies published in the last 10 years and fatwas or regulations issued by the Indonesian Ulema Council (MUI) regarding halal food and beverages. This analysis emphasized the identification of raw materials, halal milk processing, dairy product additives, and packaging as potential critical points for halal certification.

RESULT AND DISCUSSION

The Muslim population is predicted to reach 27% of the world's population by 2030, resulting in an increasing demand for halal products. In Indonesia, the implementation of the halal concept in the food industry is supported by Law No. 33 of 2014 concerning Halal Product Assurance, which provides legal certainty for Muslim consumers. LPPOM MUI issues fatwas and halal certifications in accordance with HAS 23101, a mandatory standard for the food processing industry that ensures consistent production in line with LPPOM MUI regulations. Identifying critical halal points in milk and its processed products is crucial in this process. Furthermore, SNI 3144.1:2011 stipulates that fresh milk must meet quality standards, including nutritional requirements, food safety, contamination limits, microbial counts, antibiotic residues, and heavy metals. Efforts to maintain milk quality require bacterial control through good sanitation and hygiene, which can be achieved through the processing, raw materials, and additives used (Humaida et al., 2024). Milk and its derivatives, such as cheese, cream, yogurt, butter, and others, are highly nutritious and frequently consumed animal foods. These products contain bioactive compounds such as peptides, proteins, minerals, dietary fiber, and vitamins, which function as bioactive components. Milk proteins include casein, whey protein, immunoglobulins, and lactoferrin. The nutrients in dairy products are essential for human growth and the maintenance of health (Suciati & Safitri, 2021).

Based on the results of the analysis Jumiono et al. (2023), Unprocessed milk can be declared halal if it meets all the requirements of Islamic law, while still ensuring its source and handling methods are observed (Amen et al., 2020), The initial process from milking to the milk reaching consumers is

crucial. Milk management must ensure cleanliness from milking through storage, transportation, and marketing. Transportation is carried out in closed containers, refrigerated if the storage period exceeds 2 hours. Packaging must protect the product from contamination and physical damage while maintaining quality. Farmers are required to ensure the milk is obtained through a clean milking process, as quality is influenced by hygiene and husbandry practices. Therefore, unprocessed dairy can still be categorized as halal if it comes from halal animals, is handled hygienically, is free from contamination with haram substances, and is safe for health.

Table 1. Halal critical point analysis in dairy products.

Dairy Products/ Derivatives	Main raw materials	Microbes/ enzymes/ processing aids	Processing related to critical points	Potential critical points	References
Yogurt	Cow's milk	<i>Lactobacillus bulgaricus</i> , <i>Streptococcus thermophilus</i>	Fermentation 6–12 hours	Very low alcohol risk (< 0.5%), need to ensure culture medium	Ge et al. (2024)
Greek yogurt	Cow's milk	Starter culture same as yogurt	Whey straining	Culture medium and stabilizing agents as critical points	Jørgensen et al. (2019)
Kefir	Kefir milk and grains	Yeast, lactic acid bacteria	Fermentation 24 – 48 hours	Alcohol content 0.5 – 2%	Bourrie et al. (2016)
Hard cheese (Cheddar)	Cow's milk	<i>Rennet</i> (protease enzyme)	Coagulation and ripening	Source of <i>rennet</i> (microbial/animal enzyme)	Fox et al. (2017)
Soft cheese (Mozzarella)	Cow's milk	Starter culture dan <i>rennet</i>	Coagulation, stretching	Halal status of <i>rennet</i>	Parhi et al. (2025)
Butter	milk cream	–	Churning	Food additives such as emulsifiers	Blouin et al. (2025)
Fermented butter (cultured butter)	Cream and bacterial culture	<i>Lactococcus lactis</i>	Fermentation before churning	Low alcohol risk, need to ensure the culture medium	Lei et al. (2025)
UHT milk	Cow's milk	–	Heating at 135 – 150°C	Ensure the fortification ingredients and packaging	Bermudez-Aguirre & Niemira (2022)
Pasteurized milk	Cow's milk	–	Pasteurization at 72–85°C	Sanitation and contamination potential	de Klerk & Robinson (2022)
Evaporated milk	Cow's milk	–	Partial water evaporation	Stabilizer agents	Prestes et al. (2022)
Sweetened condensed milk	Milk and high sugar	–	Sugar addition and heating treatment	Emulsifier/stabilizer	Barros et al. (2022)
Whey protein concentrate	Milk serum	Protease enzyme	Membrane filtration	Source of the protease enzyme	Mehra et al. (2021)
Ice cream	Milk, cream, and sugar	Stabilizer, emulsifier	Homogenization and freezing	Emulsifier (mono–diglycerides)	Amen et al. (2020)
Probiotic milk drink	Milk	<i>L. casei</i> , <i>B. bifidum</i> , etc.	Fermentation and cold storage	Low alcohol content and culture medium	Jang et al. (2024)

Based on the results of the analysis from Jumiono et al. (2023), The first step is to check whether a processing process is present. If none is present, then the halal status is clear (not critical). However, if a processing process is present, further investigation is needed to determine whether microbial cultivation is present and which additional or auxiliary materials are used during the process. If

microbial cultivation results in fermentation that produces alcohol (*khamr*), then the product is haram and cannot be used in halal production. If fermentation does not produce *khamr*, the process becomes a critical point that requires a review of the materials and auxiliary materials used. For example, milk fermentation using *Lactobacillus* or enzymes in cheese making is permissible, but the additional components must still be examined. If there is no microbial cultivation, physical processes such as freezing or churning are generally halal, unless additional or auxiliary materials are critical and their halal status must be verified. Therefore, the results of the analysis of halal critical points for dairy products and their derivatives are shown in Table 1.

Critical Points in Cheese Products

Cheese is a fresh or mature product resulting from the coagulation of milk. It is easily digested and rich in protein, short-chain fatty acids, vitamins, minerals, and bioactive compounds. Cheese is classified by milk type, production process, fat content, fermentation, and microbiota. As a dynamic biological and biochemical product, cheese undergoes various changes during its production (Santiago-López et al., 2018). In general, cheese is made by adding a lactic acid bacteria starter and rennet to milk to ferment casein, carbohydrates, and fats; the whey is then separated, and the curd is further processed (Zheng et al., 2021).

The halalness of microbial products is determined by the source of the microbes, the growth media, and the processing, so identifying critical points is critical (Fathurrohimi, 2022). In cheese, the risk of microbial contamination is higher due to its high-water content and the use of raw milk (Choi et al., 2016). The processing method, milk type, and hygiene knowledge significantly influence the potential for contamination. Proper sanitation practices are essential to prevent contamination and maintain product safety (Carrascosa et al., 2016).

Cheese is a solid, sour food made from raw milk, with rennet added to thicken the casein. The cheese-making process involves several stages: milk preparation, curdling, pressing, separating, curd handling, and ripening. The first critical point in cheese's halal status is its raw material. If the milk comes from a halal animal such as a cow, goat, buffalo, camel, or sheep, the cheese is still halal (Kurniati & Hafsan, 2022). However, if the milk comes from non-halal animals, the cheese is not halal. The cheese-making process and critical points for halal certification are shown in Figure 1.

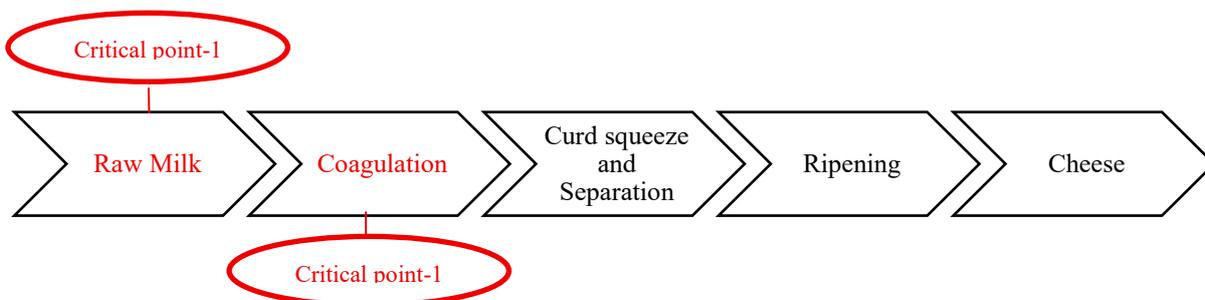


Figure 1. Critical points in the cheese processing process.

The second critical point in cheesemaking is the coagulation stage, during which the addition of ingredients initiates the coagulation process. There are two coagulation methods: enzymatic and microbiological. The enzymatic method uses the enzyme *rennet*. The halal nature of rennet depends heavily on its source; rennet can come from non-halal animals or halal animals slaughtered in violation of Islamic law. Microbiological methods can use lactic acid bacteria, which pose risks to the media used for laboratory growth. This medium may contain yeast extract, a byproduct of beer processing. Therefore, this stage is a critical point in cheese processing (Amen et al., 2020; Atma et al., 2018).

Critical Points in Yogurt Products

Yogurt is a dairy product with health benefits. It's typically made using whole milk, which gives it a more appealing aroma and flavor (Rahayu & Andriani, 2018). Figure 2 shows that yogurt is made

by fermenting milk with lactic acid bacteria, primarily *Streptococcus thermophilus* and *Lactobacillus bulgaricus*, and can be enriched with probiotic bacteria. The manufacturing process includes pasteurization, cooling, adding a starter culture, and incubation, during which additives may be added. The final stage is packaging before the product is distributed to consumers.

Factors that influence yogurt quality include the substrate, starter type, starter concentration, temperature, and incubation time. The yogurt production process, which involves microbial activity, has critical halal points that can render the resulting yogurt non-halal. The critical halal points for microbial products are the storage and microbial refreshment stages. Furthermore, the yogurt-making process involves the addition of additives such as flavorings, colorings, and stabilizers, which are also critical halal points for yogurt. In addition to the critical halal points, processed yogurt products also have critical halal production points, as determined by the National Standardization Agency (NSA), namely heat treatment, fermentation, the addition of additives, and packaging (Hapsari et al., 2022).

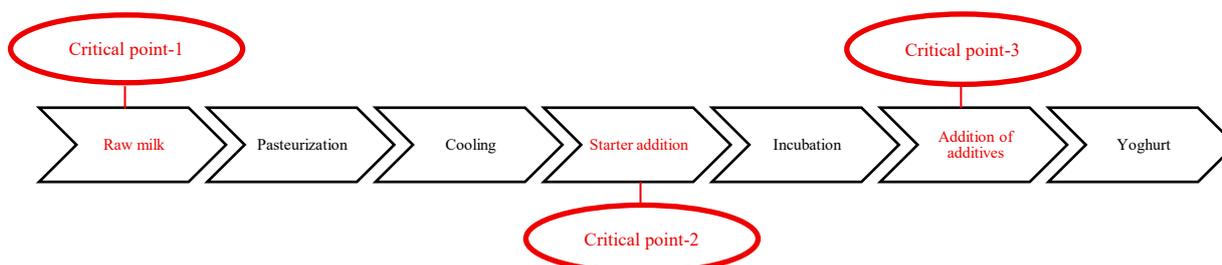
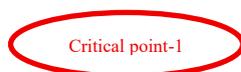


Figure 2. Critical points in the yogurt processing process.

The choice of raw materials is crucial for the halal status of yogurt. Milk from halal animals, such as cows, buffaloes, or goats, is halal, while milk from non-halal animals is haram. The addition of total solids, such as skim powder, casein, or whey, must be considered because they may come from non-halal animals. Bacterial starter cultures are halal if they are not contaminated with impure or haram materials. Still, risks arise if the growth medium contains haram or genetically modified materials from non-halal animals. Additives such as emulsifiers, flavors, stabilizers, and colorings may also be non-halal, especially gelatin derived from pork skin and bones. Thus, there are three critical points for yogurt's halal status: the addition of milk solids, the halal status of the bacterial starter culture, and additives such as gelatin, which can be replaced with plant-based ingredients like pectin to maintain its halal status (Atma et al., 2018; Faridah & Sari, 2019; Kurniati & Hafsan, 2022).

Critical Points in Butter Products

Figure 3 shows that butter is a product made from milk fat or cream in solid or soft form, with or without salt, according to SNI 01-3744-1995. Butter is concentrated on milk fat with a minimum fat content of 80%. Butter is made by churning cream at a controlled temperature until the oil-in-water emulsion changes to a water-in-oil emulsion. This process produces butter granules and buttermilk. After the buttermilk is removed, cold water and salt are added, and the remaining fat globules are processed to form butter (Chandan, 2015). Butter, as a water-in-oil emulsion, is often given additional coloring, flavor, salt (sodium chloride), a lactic acid starter culture, and minerals (Amen et al., 2020). Critical points for halal certification primarily come from additional ingredients, particularly emulsifiers such as mono- and diglycerides, which can be derived from animal or vegetable fats. Animal fat must be guaranteed to come from halal animals slaughtered according to Islamic law. Colorings and flavors also need to be verified for halal status.



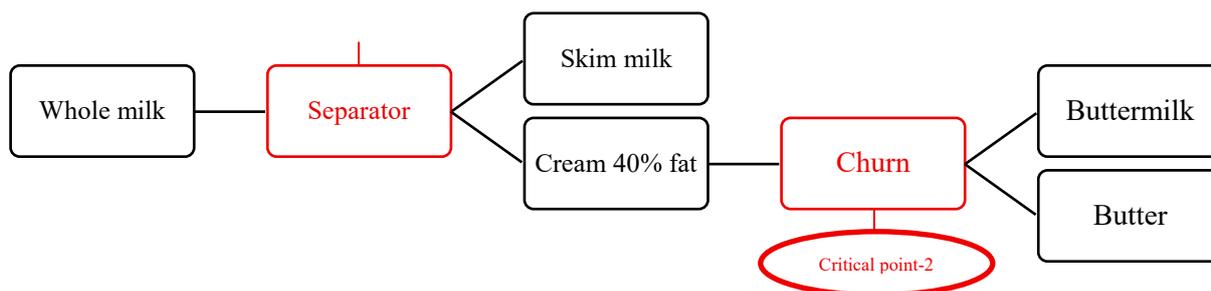


Figure 3. Critical points in the butter processing process.

Bacterial starter cultures are essentially halal if they are not contaminated with impure or haram substances. However, the growth medium can be a critical point; if it contains haram substances, the bacteria are also considered haram. Bacteria from impure sources, such as lactic acid bacteria, can still be halal if separated and cleaned (Kurniati & Hafsan, 2022). In addition to the ingredients, the processing process must also be free from contamination to ensure the butter remains halal.

Critical points in ice cream products

Figure 4 shows that ice cream is a frozen dairy product made by freezing and churning a mixture of milk and various additives. Its composition includes air, water, milk fat, non-fat milk solids, sweeteners, stabilizers, emulsifiers, flavors, and colorings, with a milk fat content of approximately 10% (Chandan, 2015). This mixture, called ice cream mix (ICM), is processed in a freezer to achieve good taste, texture, and shelf life. The processing and composition of the ingredients largely determine the quality of ice cream.

From a halal perspective, the primary concern lies with the additives. Leavening agents such as baking soda are generally halal but can become problematic when mixed with specific raising agents. Stabilizers such as gelatin, gum, sodium alginate, carrageenan, and CMC are essential for maintaining texture and preventing ice crystals. Gelatin poses a high risk because it is often derived from non-halal animals.

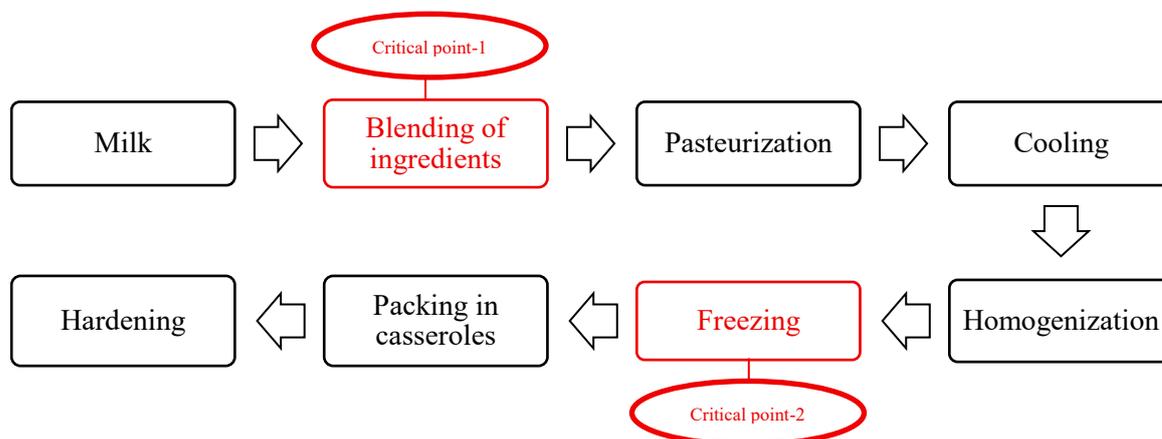


Figure 4. Critical points in the ice cream processing process.

Emulsifiers help mix the two phases and can be derived from animal or vegetable fats. Hydrocolloid-based emulsifiers are safe, while fatty acids, fatty acid salts, and modified starches have the potential to be non-halal. Sweeteners like sugar are also critical, as they are often refined using bone char, so the source of the activated carbon must be guaranteed halal. Non-fat milk solids (lactose, whey, casein) also require monitoring because the enzymes used in their production must be sourced from halal sources.

Flavors are critical ingredients because they can be derived from a mixture of animal and plant sources; therefore, the animal source and slaughtering process must be ensured to comply with Islamic law (Amen et al., 2020). Coloring, both natural and synthetic, must also be considered, especially when using coating agents such as gelatin, which must come from halal sources.

CONCLUSION

The study results indicate that critical points in raw materials are primarily related to the milk source, its handling, and the hygiene of the process from milking to storage. In fermented products such as yogurt, kefir, and cheese, microbial growth media, starter cultures, and coagulant-forming enzymes are essential aspects that must be verified for halal status. Products such as butter and ice cream may contain critical points, especially in emulsifiers, stabilizers, flavors, colorings, and gelatin, which may be derived from non-halal animal sources. Furthermore, production processes such as pasteurization, ripening, churning, and freezing must ensure there is no cross-contamination with haram ingredients. Overall, identifying and controlling critical halal points at every stage of production is essential to ensure dairy products meet halal principles and are safe for consumption.

ACKNOWLEDGEMENT

The authors thank the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia, the Directorate of Learning and Student Affairs, and Ahmad Dahlan University.

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