



Health Benefits and Market Potentials of Halal-Certified Probiotic Foods: a Global Review

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Abstract

The global demand for functional foods continues to rise, particularly among health-conscious and Muslim consumers seeking products that align with both wellness and halal integrity. Probiotics, defined as live microorganisms conferring health benefits when administered in adequate amounts, represent a rapidly expanding segment within this industry. However, halal certification of probiotic foods introduces new challenges related to microbial sources, growth media, and certification protocols. This review synthesizes current knowledge on the scientific basis of probiotics, their health benefits, and their potential in the global halal food market. It highlights the intersection between biotechnology and Islamic dietary law, exploring how industry and research sectors can collaborate to develop halal-compliant probiotic products. Finally, it discusses global market opportunities, regulatory frameworks, and future directions in halal probiotic innovation.

Keywords: probiotics, halal food, functional foods, halal certification, market potential

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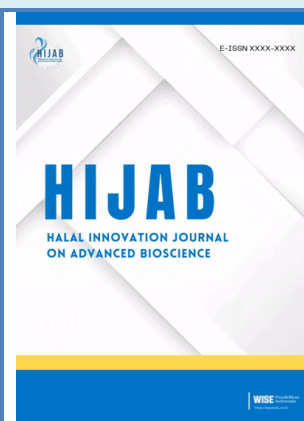
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INTRODUCTION

The integration of probiotic science and halal assurance represents a dynamic frontier in the modern food industry, shaped by simultaneous advances in biotechnology, global trade, and consumer awareness. The halal concept—derived from Islamic jurisprudence—encompasses not only the prohibition of certain ingredients (e.g., pork, blood, intoxicants) but also emphasizes hygiene, safety, and ethical sourcing throughout the production chain [1]. Consequently, halal food systems intersect strongly with the principles of *tayyib* (wholesomeness), forming a comprehensive framework that addresses both spiritual and scientific dimensions of food integrity.

Parallel to this, probiotics have gained significant attention in both academic and industrial settings. Defined as “live microorganisms which, when administered in adequate amounts, confer a health benefit on the host” [2], probiotics are now central to functional food innovation. Numerous studies demonstrate their role in maintaining gut microbiota balance, enhancing immune function, and preventing chronic metabolic and inflammatory diseases [3][4]. The global probiotics market, valued at over USD 70 billion in 2023, is expected to reach nearly USD 120 billion by 2030, reflecting sustained consumer interest in health-promoting foods [5].

However, despite their scientific promise, the incorporation of probiotics into halal food systems presents unique challenges. The halal status of probiotic products depends on the microbial source, composition of the culture media, and the entire bioprocessing environment [6]. Many commercial probiotic strains are propagated in media containing animal-derived peptones or gelatin, which can compromise halal integrity [7]. Moreover, the absence of standardized global guidelines for halal microbial verification complicates certification processes, particularly for multinational manufacturers [8].

From an industrial perspective, the convergence of halal certification and probiotic innovation opens vast economic opportunities. According to the State of the Global Islamic Economy Report 2024/25 [9], the halal food sector is projected to exceed USD 1.7 trillion by 2025, with strong demand for functional, ethical, and health-oriented products. This expansion has stimulated new research and technological development aimed at creating halal-compliant fermentation media, plant-based encapsulation materials, and halal-certified microbial banks [10].

Although numerous studies and review articles have examined the health-promoting effects of probiotics and the expansion of the halal food sector, a comprehensive synthesis linking probiotic science with halal compliance requirements remains lacking. Existing reviews tend to focus either on probiotic efficacy or halal food regulations without critically addressing the technological, regulatory, and commercial challenges associated with developing halal-certified probiotic products. Consequently, there is a need for an integrated assessment that connects microbial biotechnology, halal assurance, consumer trust, and market potential. This review addresses that gap by critically evaluating the scientific evidence on probiotic functionality, identifying key halal compliance challenges across the production process, and exploring emerging opportunities in the global halal probiotic market. Through this interdisciplinary approach, the review provides insights and future directions for the development of scientifically validated and halal-compliant probiotic foods.

METHODS

Methodology of Literature Review

This review employed a systematic literature search across Scopus, Web of Science, PubMed, and ScienceDirect using the keywords “probiotic,” “halal food,” “halal certification,” “functional foods,” and “market potential.” Publications published between 2014 and 2025 were considered. Studies were excluded if they focused exclusively on non-halal products without discussing halal-related aspects, certification, or compliance; involved only clinical or medical trials without relevance to the food, pharmaceutical, cosmetic, or biotechnology industries; or did not report industrial applications, commercialization potential, production processes, or implications for industry practices. In addition, the reference lists of relevant papers were screened to identify further eligible studies. The search process yielded 85 documents for review, of which 38 were selected and cited directly in this paper.

RESULT AND DISCUSSIONS

Scientific Overview of Probiotics

Probiotics are defined by the [2] as “live microorganisms which, when administered in adequate amounts, confer a health benefit on the host.” The most widely studied genera include *Lactobacillus*, *Bifidobacterium*, *Bacillus*, and *Saccharomyces*, each exhibiting distinct physiological and biochemical traits beneficial to host health. The effectiveness of probiotics depends on their ability to survive gastrointestinal conditions, adhere to intestinal epithelium, and interact with host immune cells.

Mechanistically, probiotics maintain gut homeostasis through several biological pathways. They compete with pathogenic bacteria for adhesion sites and nutrients, secrete antimicrobial metabolites such as organic acids and bacteriocins, and produce short-chain fatty acids that modulate intestinal pH and host metabolism. In addition to local effects, probiotics influence systemic physiology through the gut–brain axis, affecting neurological and behavioral functions, and the gut–liver axis, which regulates lipid and glucose metabolism. The immunomodulatory role of probiotics—particularly in enhancing mucosal immunity and balancing T-helper cell responses—has also been widely documented. Current studies indicate that probiotics can influence host health through interactions with the gut microbiota, immune system, and metabolic pathways. Nevertheless, these effects are strain-specific and context-dependent, requiring further investigation to establish their clinical significance.

A growing body of scientific evidence supports the role of probiotics in promoting human health and preventing disease. Numerous clinical and preclinical studies have demonstrated their efficacy in managing gastrointestinal disorders such as antibiotic-associated diarrhea, inflammatory bowel disease, and irritable bowel syndrome. Probiotics enhance epithelial barrier integrity, suppress pro-inflammatory cytokines, and stimulate mucin production, leading to improved gut resilience against pathogens.

Beyond gastrointestinal health, probiotics have demonstrated benefits in systemic and metabolic conditions. Regular consumption has been linked to improved lipid profiles, reduced obesity risk, and modulation of insulin sensitivity. Certain *Lactobacillus* and *Bifidobacterium* strains produce bioactive compounds with antioxidant and antihypertensive properties, contributing to cardiovascular health. Recent studies indicate that specific probiotic strains may help alleviate symptoms of stress and anxiety through gut–brain axis modulation, although current evidence remains moderate and requires further clinical validation. where specific strains—termed psychobiotics—may influence mood and cognitive performance through neurotransmitter modulation and inflammatory pathway regulation.

While probiotics offer substantial scientific and health value, their integration into halal food systems introduces complex regulatory and biotechnological challenges. The primary concern lies

in the source of microbial strains and culture media components used during production. Many commercial probiotics are cultivated in media containing animal-derived ingredients such as tryptone, peptone, and gelatin—often obtained from non-halal sources. Such ingredients compromise halal integrity, even when the final microbial biomass itself appears non-animal in origin.

Moreover, cross-contamination risks may occur during large-scale fermentation and downstream processing, particularly when facilities handle both halal and non-halal materials. Halal verification thus extends beyond the microbial species to include every stage of bioprocessing, from inoculum preparation to purification and encapsulation. Advances in biotechnology and halal-compliant formulation have begun to address these concerns. Researchers have developed plant-based and yeast-extract media that can effectively replace animal-derived nutrients without compromising probiotic growth or viability. Halal-friendly encapsulation materials, such as alginate and carrageenan, are increasingly adopted to ensure compliance.

Halal Certification and Industrial Perspectives

Halal certification for probiotic products requires a comprehensive assurance system that addresses raw material sourcing, production processes, facility management, and supply chain traceability. National and regional halal authorities, such as LPPOM MUI (Indonesia), JAKIM (Malaysia), and SMIIC/OIC standards (Organization of Islamic Cooperation's Standards and Metrology Institute for Islamic Countries), provide frameworks and technical guidance for halal assurance. LPPOM MUI's Halal Assurance System [11] emphasizes written procedures for critical activities—such as incoming material checks, production, cleaning, storage, and transportation—to prevent contamination and ensure product integrity, which is essential for biologically derived products like probiotics [11].

Despite progress, gaps remain—particularly in globally harmonized guidelines for microbial verification, validated halal-friendly process controls for large-scale fermentation, and international mutual recognition of halal status for biotechnologically derived products. Addressing these gaps will require interdisciplinary collaboration among microbiologists, food technologists, halal auditors, and policymakers to develop technical annexes (e.g., approved ingredient lists, validated alternative media formulas, and sampling protocols) that can be incorporated into existing halal assurance frameworks.

Examples from Southeast Asia have been reported to demonstrate the potential application of these approaches in industrial settings: several regional manufacturers have successfully launched halal-certified probiotic yogurts, fermented beverages, and dietary supplements by adopting plant-based media, segregated production lines, and certified halal packaging suppliers. Collaboration between research institutions and halal bodies has accelerated the translation of laboratory findings (e.g., alternative media formulations and encapsulation methods) into scalable manufacturing processes. These examples demonstrate that with targeted R&D and strict halal assurance systems, probiotic products can meet both scientific efficacy and religious compliance [7], [10].

Traceability and digital tools also play a crucial role in halal assurance for probiotics. Electronic supply-chain records, blockchain-based traceability pilots, and AI-assisted risk assessment tools can document the origin of strains and media components, track processing steps, and flag deviations that could compromise halal status. Regulatory initiatives—such as standardized halal labeling rules and audit criteria from SMIIC/OIC—support harmonization but

require technical adaptation for microbial products, including protocols for strain authentication and media verification [8][12]

Industrial solutions for these verification challenges are emerging. Researchers and manufacturers have developed plant-based and yeast-extract media that can support lactic acid bacteria and other probiotic strains without animal-derived nutrients, demonstrating comparable growth and viability in several studies. Such alternatives help meet halal requirements while maintaining production efficiency. Moreover, downstream technologies—such as microencapsulation using halal-compatible polymers (e.g., alginate, carrageenan), dehydration methods optimized for viability, and controlled-atmosphere packaging—are increasingly implemented to enhance shelf stability and product performance in halal probiotic foods [13][15].

Probiotic products present unique verification challenges compared with conventional food items. The halal status depends not only on the final product but also on the provenance of microbial strains, the composition of culture media, and processing aids. Growth media components such as peptones, tryptone, and gelatin—commonly used in laboratory and industrial fermentation—may be derived from non-halal sources (e.g., porcine or non-slaughtered animal materials), rendering the produced biomass problematic for halal certification. Additionally, cross-contamination risks arise when production lines or shared equipment are used for both halal and non-halal items, necessitating strict segregation, validated cleaning procedures, and risk-based sampling during audits [6][16].

Different certification bodies apply similar but not identical requirements. For example, Malaysia's Manual Procedure for Malaysia Halal Certification (MPPHM) and JAKIM's online MYeHALAL portal outline documentation, ingredient disclosure, and facility audit procedures for manufacturers seeking halal approval. At the international level, SMIIC publishes harmonized halal standards intended to facilitate mutual recognition among member states; these standards increasingly address technical aspects of production and inspection that are relevant to microbial products [12][17].

Global Market Potentials of Halal Probiotic Foods

The global market for halal-certified probiotic foods has shown remarkable growth potential, reflecting the convergence of two major global trends: the increasing demand for functional foods and the expanding influence of the halal industry. As consumers around the world become more health-conscious, probiotics are gaining popularity for their scientifically proven benefits on gut health, immunity, and metabolic balance. Simultaneously, halal certification has evolved beyond a religious requirement to represent quality, hygiene, ethical sourcing, and transparency—attributes that appeal to both Muslim and non-Muslim consumers alike.

Market Size and Growth Dynamics

The Asia-Pacific region remains the largest and fastest-growing market for probiotics and halal-certified foods [18]. The probiotic market in Asia-Pacific reached approximately USD 7.5 billion in 2023, driven by urbanization, a growing middle-class population, and heightened awareness of digestive wellness. Similarly, the Halal Nutraceuticals Market Forecast [19] projects that the global halal nutraceuticals segment—including probiotic supplements, functional foods, and beverages—will expand at a compound annual growth rate (CAGR) exceeding 6%, with Indonesia, Malaysia, and Pakistan leading the market share.

These figures underscore that the synergy between probiotic innovation and halal assurance is not merely a niche opportunity but a mainstream direction in the health and wellness industry.

Market Segments and Distribution Channels

Functional probiotic foods dominate the market over supplements, accounting for more than 50% of total probiotic product sales in the Asia-Pacific region [20]. Common product formats include yogurt drinks, fermented dairy alternatives, snack bars, and capsules made from halal-certified gelatin substitutes such as seaweed or tapioca-based materials.

Distribution strategies are also evolving. While supermarkets and hypermarkets remain the primary channels, the growth of e-commerce platforms has accelerated the accessibility of halal probiotic products to a wider audience, particularly in Southeast Asia. Online health stores and digital halal marketplaces have played a vital role in bridging consumer education and product reach.

Key Market Drivers

Several major drivers are shaping the global halal probiotic industry.

First, rising health awareness has made gut health a top concern globally. Increased incidences of gastrointestinal and metabolic disorders have elevated probiotics to a daily wellness necessity. Clinical evidence supporting probiotic efficacy has strengthened consumer confidence, particularly when combined with halal integrity.

Second, consumer preference for clean-label and ethically sourced products has reshaped purchasing behavior. Halal probiotic foods appeal to consumers who seek products free from alcohol, porcine derivatives, or synthetic ingredients—traits that align with broader “clean eating” movements.

Third, supportive regulatory frameworks in Muslim-majority countries—such as Indonesia’s mandatory halal certification and Malaysia’s JAKIM-led Halal Assurance System—create both accountability and competitive advantage for manufacturers. These systems enhance product traceability and consumer trust.

Lastly, demographic factors play a key role. The growing young and urban Muslim population, particularly in Southeast Asia and the Middle East, demonstrates strong purchasing power and a preference for modern health-oriented lifestyles, positioning halal probiotic foods as an attractive category.

Regional Opportunities and Geographical Expansion

Regional trends reveal significant opportunities for halal probiotic expansion.

In Asia-Pacific, nations such as Indonesia, Malaysia, and India are emerging as innovation hubs, leveraging strong halal infrastructures and abundant local probiotic strains derived from fermented traditional foods. China presents a unique case, with a growing demand for probiotic drinks among Muslim minorities and non-Muslims seeking quality-certified products.

In the Middle East and North Africa (MENA), rising awareness of gut health, combined with a cultural affinity for fermented dairy products, provides fertile ground for halal probiotic beverages. Government-led initiatives in Saudi Arabia and the UAE are fostering halal industry diversification, which includes functional foods and nutraceuticals.

Beyond traditional Muslim markets, Europe and North America are showing increasing openness to halal probiotic foods, driven by ethical consumerism and multicultural dietary inclusivity. In these regions, halal labeling adds a dimension of trust and quality assurance that resonates even with non-Muslim consumers.

Market Challenges and Risks

Despite the growth trajectory, several challenges persist.

Halal-certified probiotic foods often command premium prices due to higher costs in sourcing halal-compliant culture media, encapsulation agents, and certification processes. This may limit accessibility for lower-income segments.

Another critical barrier lies in consumer awareness. While many Muslim consumers prioritize halal certification, not all understand the scientific significance of probiotics, their health benefits, or the difference between halal-certified and conventional strains. Educational campaigns by industry and health authorities are necessary to build literacy in both halal integrity and probiotic functionality.

Additionally, regulatory fragmentation remains a major challenge. Variations in halal standards among certification bodies—such as JAKIM (Malaysia), MUI (Indonesia), and SMIIC (OIC)—can complicate international trade and increase compliance costs for global producers. Harmonization efforts by OIC-SMIIC and mutual recognition agreements are crucial to achieving smoother market integration.

Outlook and Strategic Implications

In summary, the global halal probiotic market stands at a pivotal intersection of health science and ethical consumption. The long-term success of this sector depends on the ability of producers to integrate halal compliance with robust scientific validation and consumer-centric marketing. Companies that can combine probiotic efficacy, halal integrity, and accessible pricing—supported by transparent supply chains and innovative delivery technologies—will define the next generation of functional halal foods in global markets.

Future Directions and Research Opportunities

The future of halal-certified probiotic foods lies in the convergence between biotechnology, data-driven innovation, and Islamic ethical frameworks. As scientific understanding of probiotics deepens, the need for comprehensive systems that ensure both health efficacy and halal compliance becomes increasingly urgent. The development of a standardized halal microbial database requires collaboration among researchers, regulatory authorities, and halal certification bodies to ensure data validity and accessibility. Such a database could streamline halal verification processes, improve traceability, and support the efficient development of halal-compliant products in the food, pharmaceutical, and biotechnology industries, which would serve as repositories of verified probiotic strains originating from halal sources. Such databases could facilitate transparent verification for researchers and manufacturers, reducing the uncertainty surrounding microbial origin and culture media components.

Advancements in genomics, metabolomics, and proteomics technologies also open new opportunities to characterize probiotic strains at the molecular level. These approaches allow the identification of genetic markers associated with safety, efficacy, and halal suitability. Parallel to these scientific advances, artificial intelligence and digital traceability systems are expected to play a transformative role in monitoring production chains and predicting potential non-halal risks during fermentation and processing.

Furthermore, future progress in halal probiotic development will require strong cross-sector collaboration among academia, food technologists, and halal certification authorities. Joint initiatives could establish standardized global certification protocols, harmonizing diverse regional frameworks and facilitating international trade of halal-certified functional foods. Investing in interdisciplinary research—combining microbiology, biotechnology, ethics, and policy—will enhance both scientific rigor and consumer confidence. Collectively, these

innovations will strengthen the scientific credibility, economic competitiveness, and global reach of halal-certified probiotic foods.

CONCLUSION

Halal-certified probiotic foods demonstrate significant potential for promoting health while meeting religious requirements, supported by their documented health benefits and expanding global market demand. However, maintaining halal integrity throughout the bioprocessing chain remains a major scientific and regulatory challenge. Future research should focus on developing standardized halal microbial resources and integrated certification systems that align with international quality and safety standards. Stronger collaboration among academia, industry, and halal certification bodies will be essential to drive innovation, ensure product credibility, and strengthen global consumer trust.

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REFERENCES

- [1] M. A. Alzeer and U. Rieder, "The importance of halal and tayyib in the future food industry," *Trends in Food Science & Technology*, vol. 71, pp. 161–167, 2018, doi: 10.1016/j.tifs.2017.10.015.
- [2] FAO/WHO, "Health and Nutritional Properties of Probiotics in Food Including Powder Milk with Live Lactic Acid Bacteria," FAO/WHO Expert Consultation Report, 2001.
- [3] C. Hill et al., "Expert consensus document: The International Scientific Association for Probiotics and Prebiotics consensus statement," *Nature Reviews Gastroenterology & Hepatology*, vol. 11, pp. 506–514, 2014.
- [4] J. Plaza-Díaz et al., "Mechanisms of action of probiotics," *Advances in Nutrition*, vol. 10, pp. S49–S66, 2019.
- [5] Grand View Research, "Probiotics Market Size Report," 2024.
- [6] M. N. M. Ibrahim, N. H. A. Rahman, and S. Shafie, "Challenges in halal certification of microbial-derived food ingredients," *Malaysian Journal of Halal Science and Technology*, vol. 7, no. 2, pp. 77–86, 2021.

- [7] H. Arief et al., ...Abd Rahman, A., Asyraf, M. F., & Ahmad, S. (2022). *Halal food industry 4.0: Integrating technology and compliance in global supply chains*. Journal of Halal Research, 5(2), 45–58. <https://doi.org/10.1007/jhr.2022.0045>
- [8] Othman, R., & Saad, M. S. (2020). *Microbial biotechnology and halal assurance: Emerging intersections*. International Journal of Halal Studies, 2(1), 31–49.
- [9] DinarStandard, *State of the Global Islamic Economy Report 2024/25*. New York, NY, USA: DinarStandard, 2024. [Online]. Available: <https://www.dinarstandard.com/insights/sgier-2024-25>
- [10] A. Abd Rahman, M. F. Asyraf, and S. Ahmad, “Halal food industry 4.0: Integrating technology and compliance in global supply chains,” *Journal of Halal Research*, vol. 5, no. 2, pp. 45–58, 2022, doi: 10.1007/jhr.2022.0045.
- [11] LPPOM MUI. (2020). *HAS 23000: Halal Assurance System – Requirements for Halal Certification*. Majelis Ulama Indonesia. <https://www.halalmui.org>
- [12] SMIIC (Standards and Metrology Institute for Islamic Countries). (2023). *OIC/SMIIC 1: General Guidelines on Halal Food*. SMIIC Secretariat.
- [13] Ayu, R., Huda, N., & Ramli, N. S. (2023). *Plant-based alternative media for lactic acid bacteria growth: Toward sustainable and halal bioprocessing*. Foods, 12(4), 615. <https://doi.org/10.3390/foods12040615>
- [14] Wang, Y., Wu, J., & Zhang, H. (2022). *Microencapsulation of probiotics for improved survival in food matrices: A review of materials and techniques*. Food Hydrocolloids, 126, 107422. <https://doi.org/10.1016/j.foodhyd.2021.107422>
- [15] Saeed, A., Liu, J., & Zhao, Y. (2024). *Advances in encapsulation technologies for probiotic viability enhancement in functional foods*. Comprehensive Reviews in Food Science and Food Safety, 23(2), 765–789. <https://doi.org/10.1111/1541-4337.13125>
- [16] Halal Foundation. (2021). *Guidelines for microbial product verification in halal industries*. Halal Foundation Publications.
- [17] Jabatan Kemajuan Islam Malaysia (JAKIM). (2022). *Manual Procedure for Malaysia Halal Certification (MPPHM 2022)*. Department of Islamic Development Malaysia. <https://www.halal.gov.my>
- [18] Ken Research. (2024). *Asia-Pacific probiotics market outlook to 2030*. <https://www.kenresearch.com/industry-reports/asia-pacific-probiotics-market>
- [19] Inkwood Research. (2025). *Global halal nutraceuticals market forecast 2025–2032*. <https://www.inkwoodresearch.com/reports/halal-nutraceuticals-market>
- [20] Mordor Intelligence. (2024). *Asia-Pacific probiotics market industry report*. <https://www.mordorintelligence.com/industry-reports/asia-pacific-probiotics-market-industry>